Load Distribution

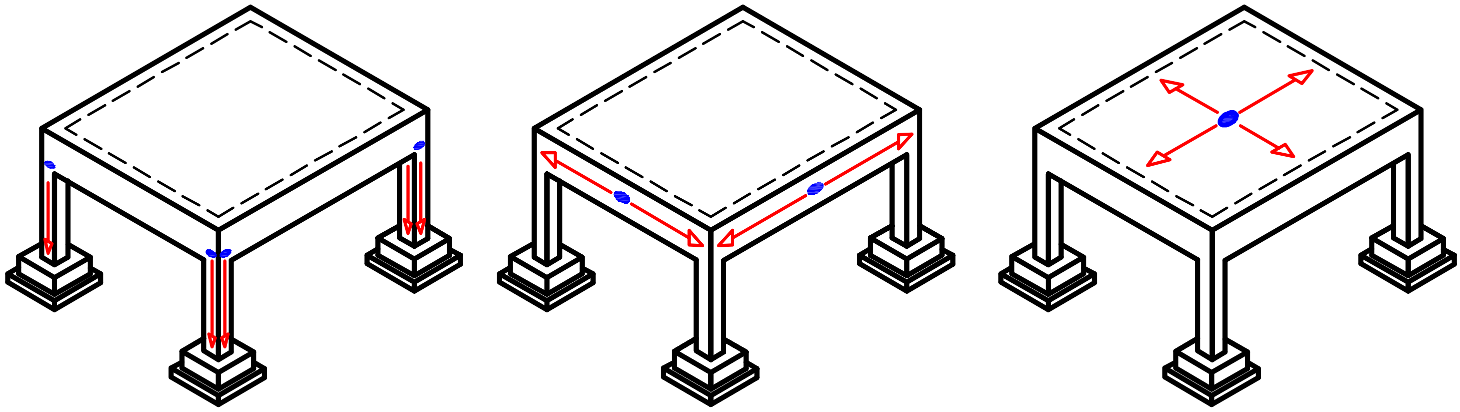
نسألكم الدعاء

Load Distribution. Table of Contents.

Introduction.

أى حمل موجود فى منشأ ينتقل إلى البلاطه و منه إلى الكمرات و منه إلى الأعمده و منه إلى القواعد و منه إلى الأرض .

* الحمل ← البلاطه ← الكمرات ← الأعمده ← القواعد ← الأرض .



من البلاطه للكمره   من الكمره للعمود   من العمود للقاعده

❖ لكى نصمم البلاطات يجب أن نحدد الحمل الواقع عليها .
و لكى نصمم الكمرات يجب أن نحدد الحمل الواقع عليها من البلاطات .
و لكى نصمم الأعمده يجب أن نحدد الحمل الواقع عليها من الكمرات .
و لكى نصمم القواعد يجب أن نحدد الحمل الواقع من الأعمده .

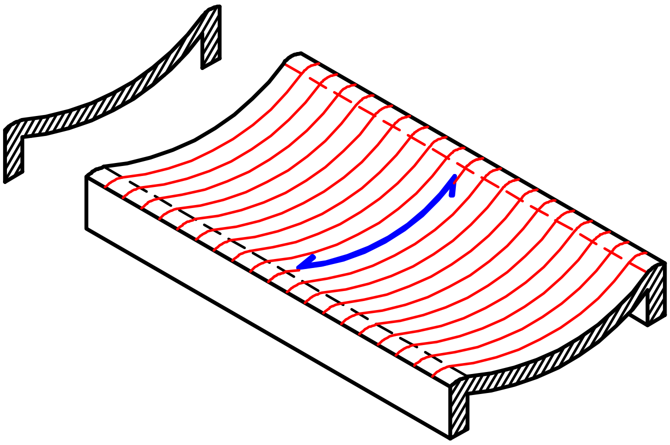
و معنى الـ **Load Distribution** هو توزيع الأحمال من البلاطه إلى الكمرات و ذلك لكى نستطيع أن نحدد الأحمال الواقعه على كل كمره لكى نرسم لها الـ **S.F.D. , B.M.D.** و عن طريق الـ **S.F.D. , B.M.D.** نستطيع أن نصمم الكمره (أى أن نعرف أبعادها و نحدد تسليحها) .

Types of Slabs. أنواع البلاطات

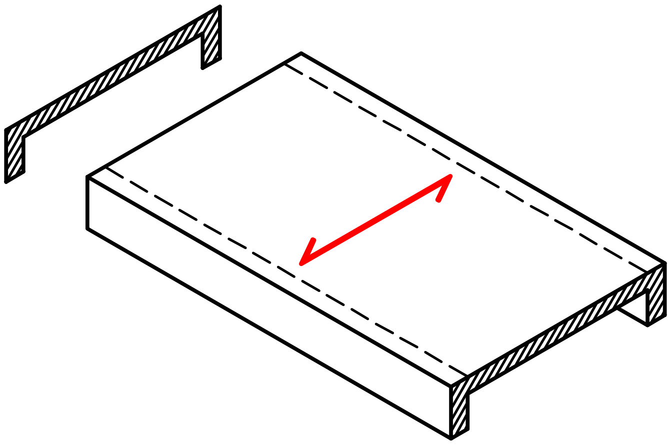
يتم تقسيم البلاطات على حسب الاتجاهات التى يسير فيها الحمل .

① One Way Slab.

ال *One Way Slab* هى عباره عن بلاطه يسير فيها الحمل فى إتجاه واحد فقط.



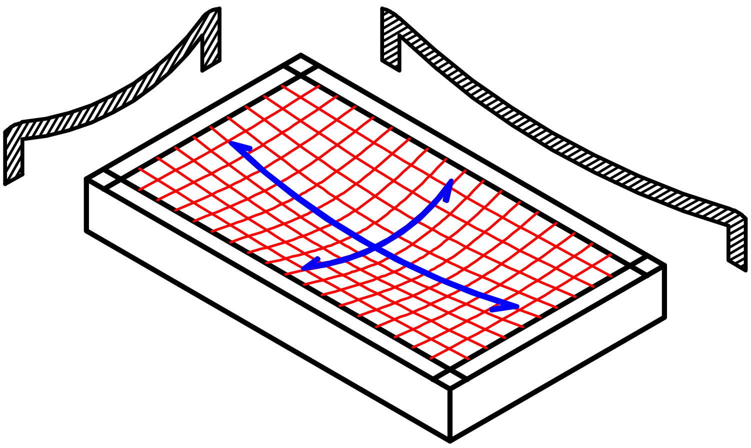
After Loading



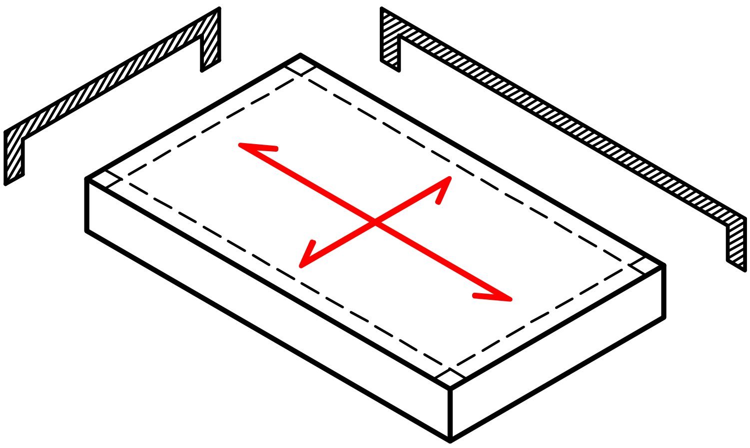
Before Loading

② Two Way Slab.

ال *Two Way Slab* هى عباره عن بلاطه يسير فيها الحمل فى الإتجاهين .



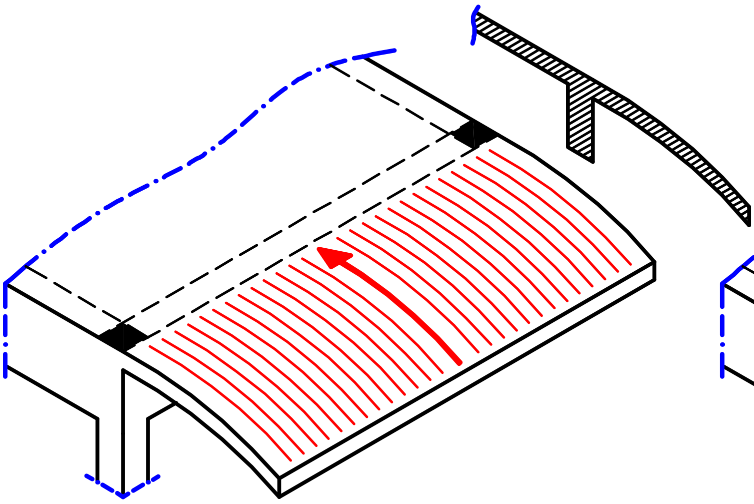
Before Loading



Before Loading

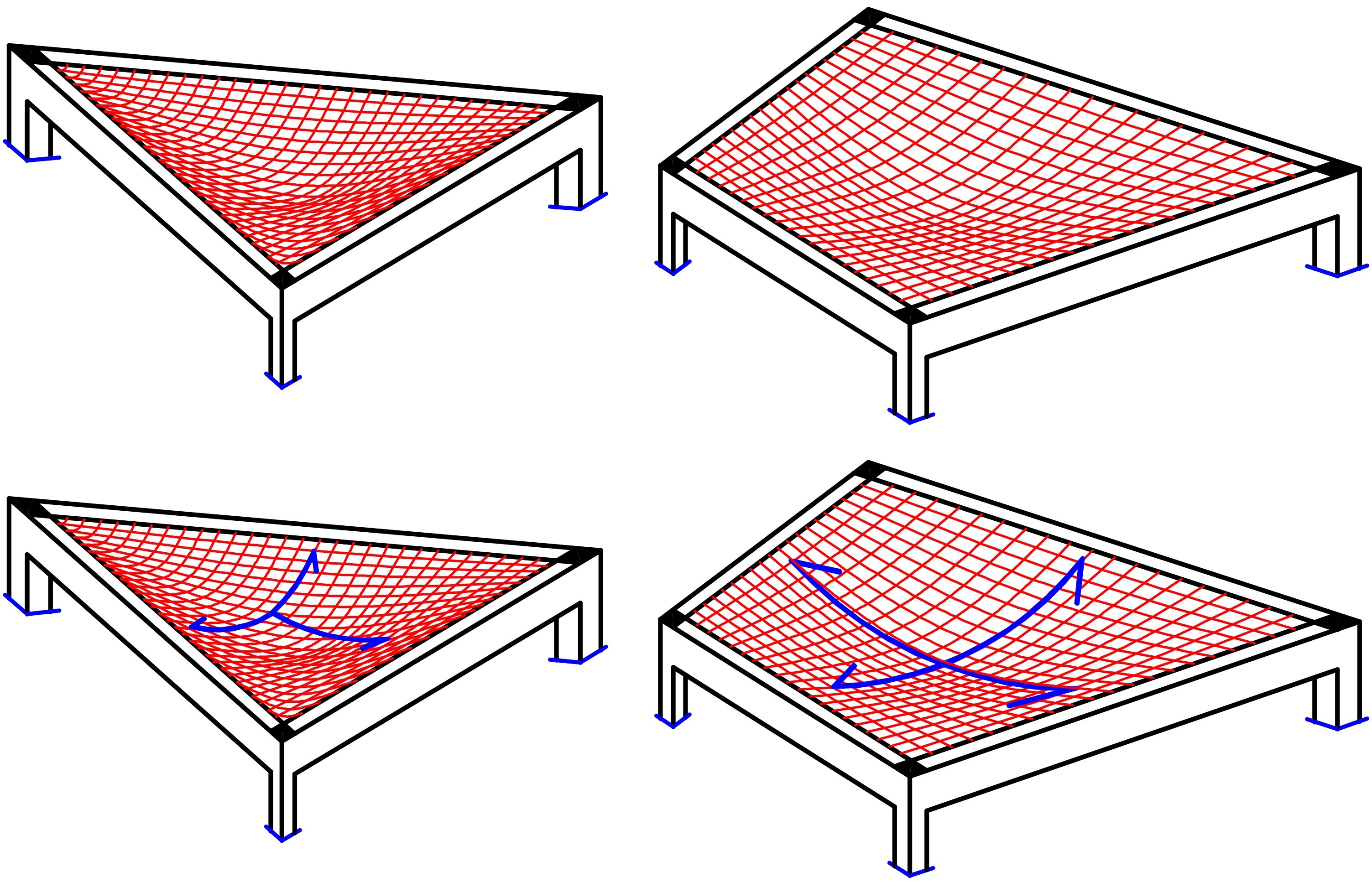
③ Cantilever Slab.

ال **Cantilever Slab** هى عباره عن بلاطه محموله على كمره واحده .



④ Irregular Slabs.

ال **Irregular Slabs** هى بلاطات أشكالها غير منتظمه .



Load Distribution Pattern For Slabs.

توزيع أحمال البلاطات على الكمرات هى طريقه معقده للغايه

و تعتمد على عوامل كثيره أهمها :

١ـ نسبه أبعاد البلاطه لبعضها و استمراريتها فى الاتجاهين *rectangularity* (r)

٢ـ حاله ارتكاز البلاطه على الكمره .

٣ـ نسبه تخانه البلاطه الى الكمره *relative stiffness*.

٤ـ تفاصيل التسلح بين البلاطه و الكمره *hinged or rigid joint*.

٥ـ توزيع الاعمده و طريقه اتصالها مع الكمرات و البلاطات .

و للتسهيل سيتم توزيع أحمال البلاطات على الكمره .
معتمده على الشكل النهائى المتوقع لانهيارالبلاطه (*Yield Line Theory*)

---

① One Way Slab.

المحموله على كمرتين متوازيتين فقط

توزيع الـ *Load* على الكمرات يتم عمل خط فى منتصف البلاطه موازى للكمرتين .

المحموله على ٤ كمرات

توزيع الـ *Load* على الكمرات يتم عمل خط فى منتصف البلاطه موازى للكمرتين الاطول .

② Two Way Slab.

لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات

③ Irregular Slab.

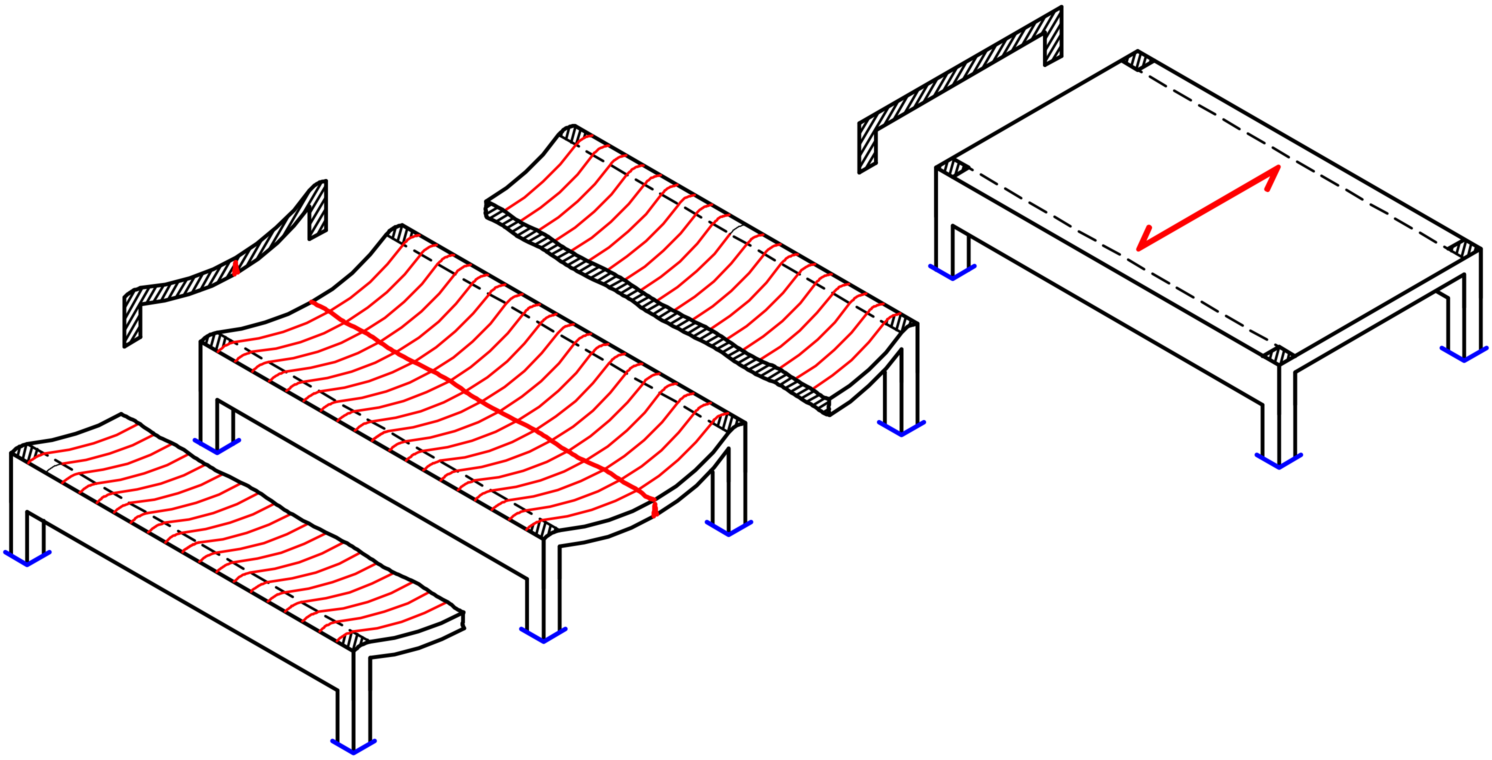
لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات

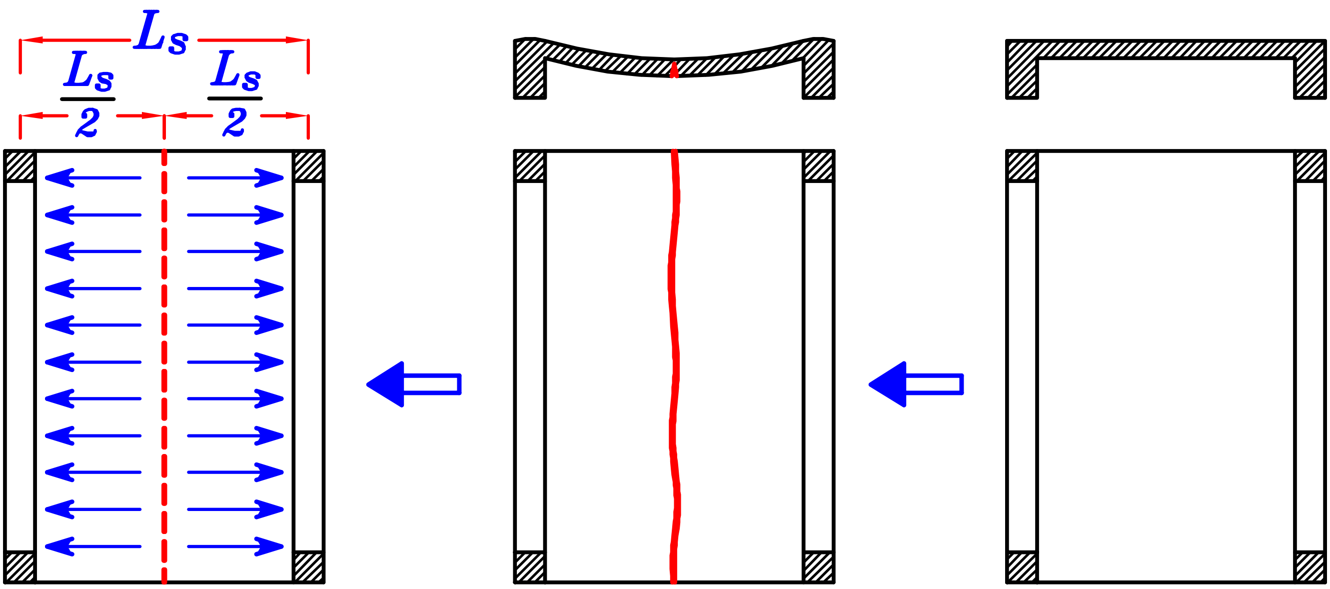
④ Cantilever Slab.

لان البلاطه الـ *Cantilever* محموله بالكامل على الكمره
فلا يوجد توزيع للاحمال انما البلاطه كلها محموله على نفس الكمره

1-For Rectangular Slabs rested on 2 parallel Beams.

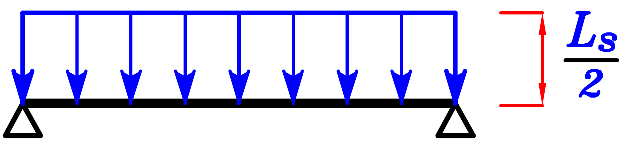
البلاطات المستطيله المحموله على كمرتين متوازيتين .





البلاطه المحموله على كمرتين متوازيتين تكون دائما **One Way**

و لتوزيع الـ **Load** على الكمرات يتم عمل خط فى منتصف البلاطه موازى للكمرتين .



2-For Rectangular Slabs rested on 4 Beams.

البلاطات المستطيله المحموله على ٤ كمرات

البلاطات المحموله على أربع كمرات ممكن أن تكون *one way* أى الحمل يسير فى اتجاه واحد أو ممكن أن تكون *Two way* أى الحمل يسير فى الاتجاهين .

و لتحدد اذا كانت البلاطه *one way or Two way* نحسب معامل استطاله البلاطه (γ)

(γ) Degree of rectangularity. معامل استطاله البلاطه

$$\boxed{\gamma = \frac{m\ L}{\grave{m}\ L_s}}$$

L ---- الطول الكبير للبلاطه

L_s ---- الطول الصغير للبلاطه

$m\ ,\ \grave{m}$ are Factors depends on the Continuity of the slab strip.

the strip			
m OR $\grave{m}$	1.0	0.87	0.76

IF $\boxed{\gamma > 2.0}$ ∴ the Slab is *One way slab.*

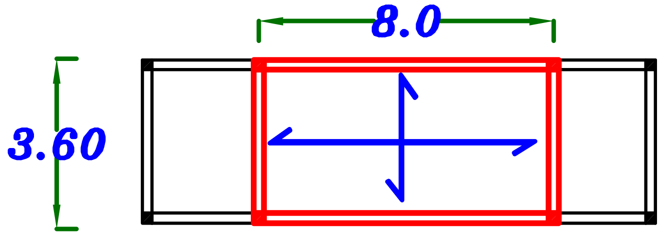
الحمل كله يسير فى اتجاه واحد فقط هو الاتجاه القصير (الموجود فى أسفل فى المقام).

IF $\boxed{\gamma \leqslant 2.0}$ ∴ the Slab is *Two way slab.* الحمل يسير فى الاتجاهين

Example.

$$\gamma = \frac{0.76\ (8.0)}{1.0\ (3.60)} = 1.68 < 2.0$$

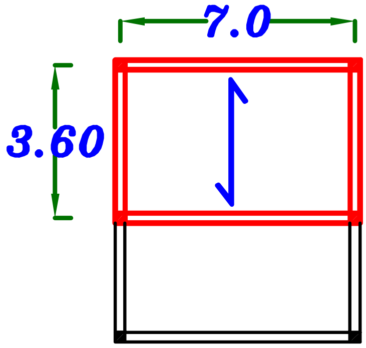
Two way



Example.

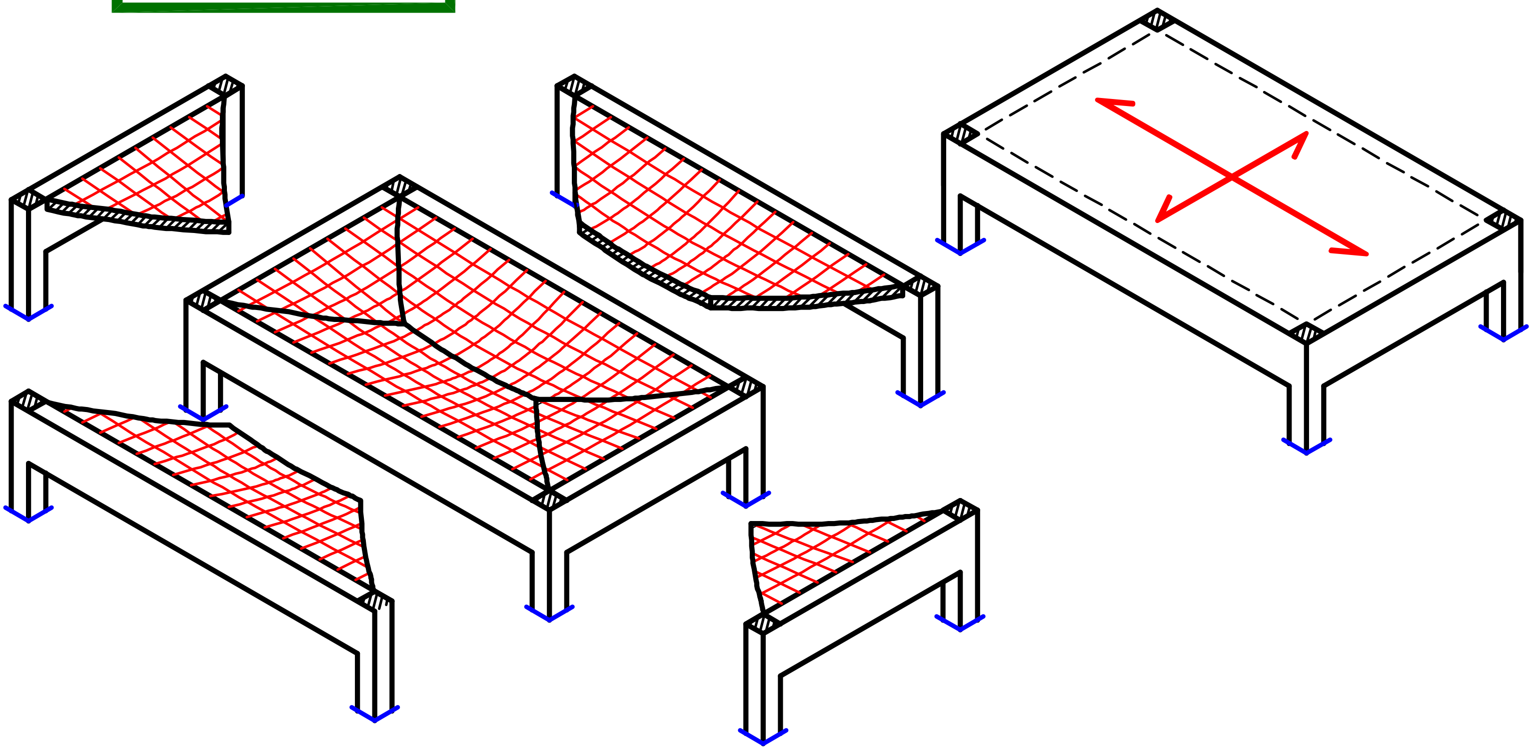
$$\gamma = \frac{1.0\ \ (7.0)}{0.87\,(3.60)} = 2.23 > 2.0$$

One way

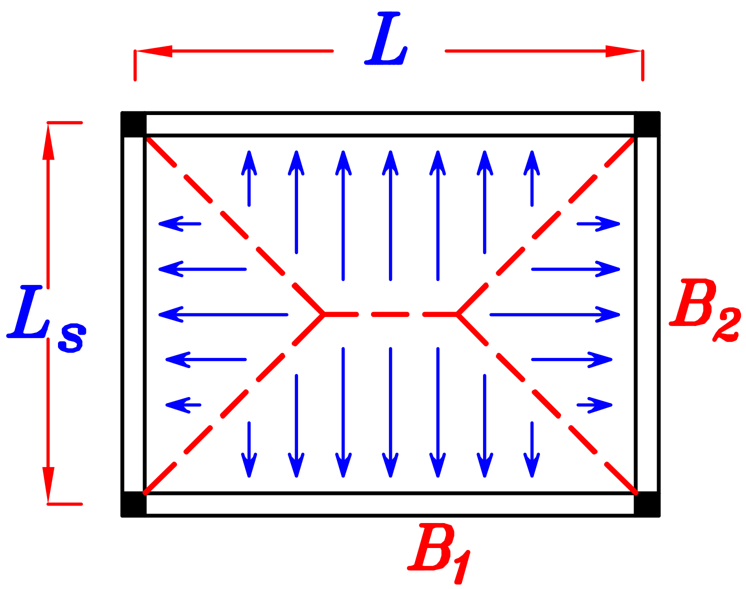


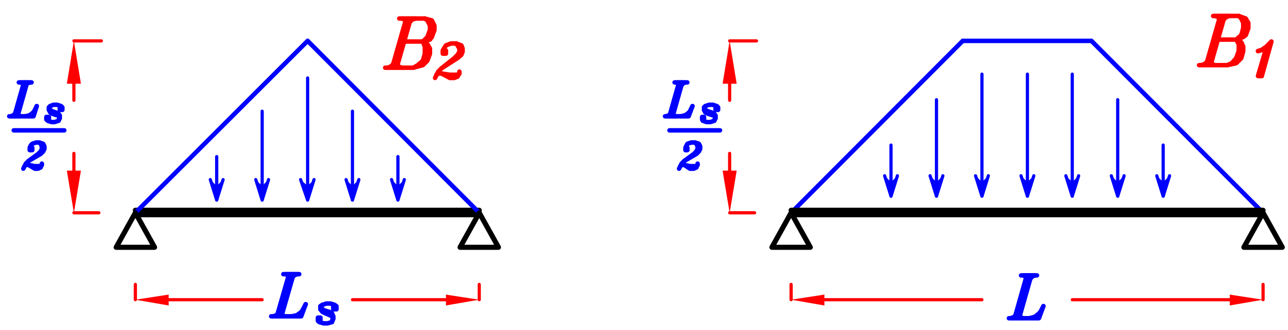
$$\boxed{\gamma = \frac{L}{L_s}}$$ ممكن للتسهيل ممكن حساب

$\frac{L}{L_s} \leqslant 2.0$ Two way الحمل يسير فى الاتجاهين

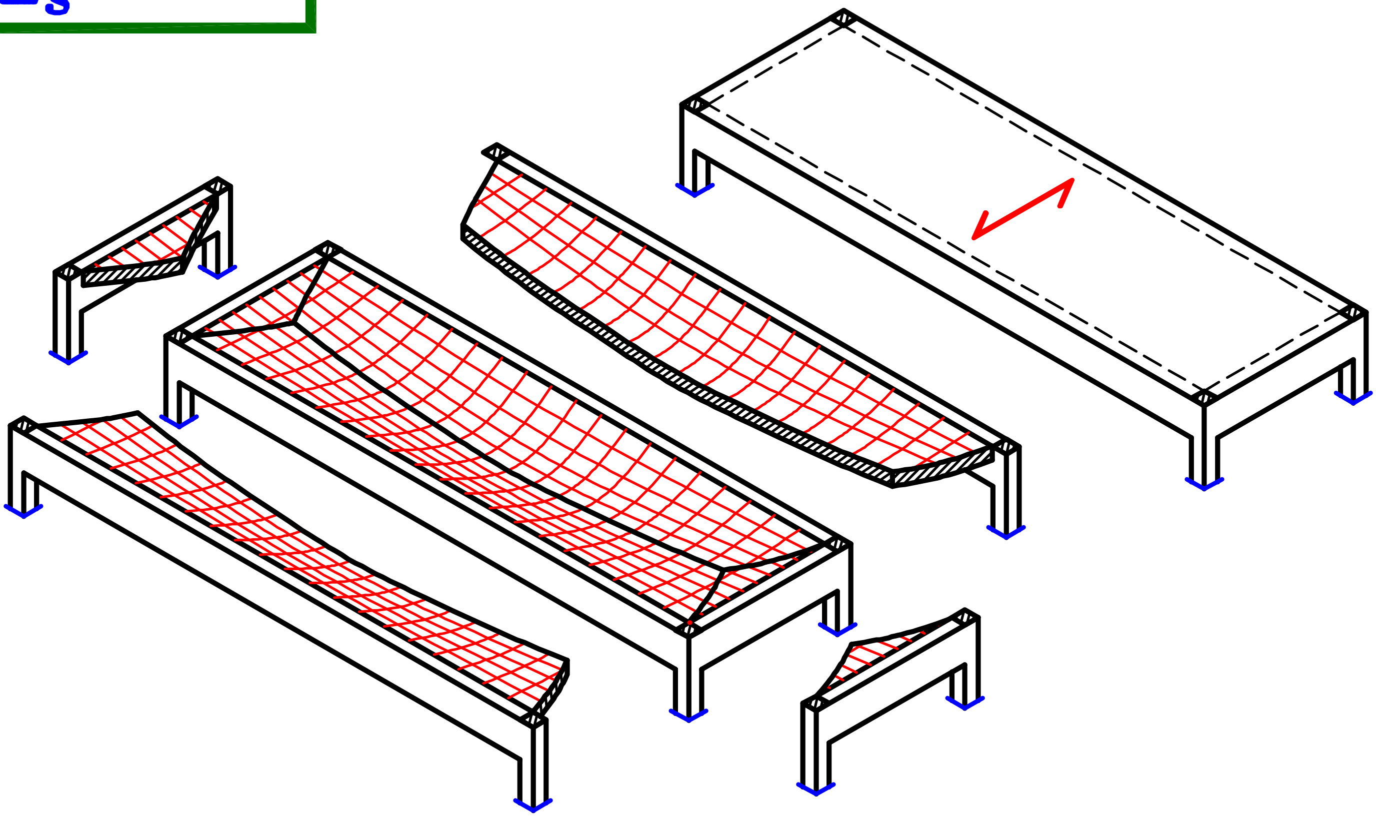


لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات





$\frac{L}{L_s} > 2.0$ **One way** نعتبر الحمل يسير فى الاتجاه القصير فقط

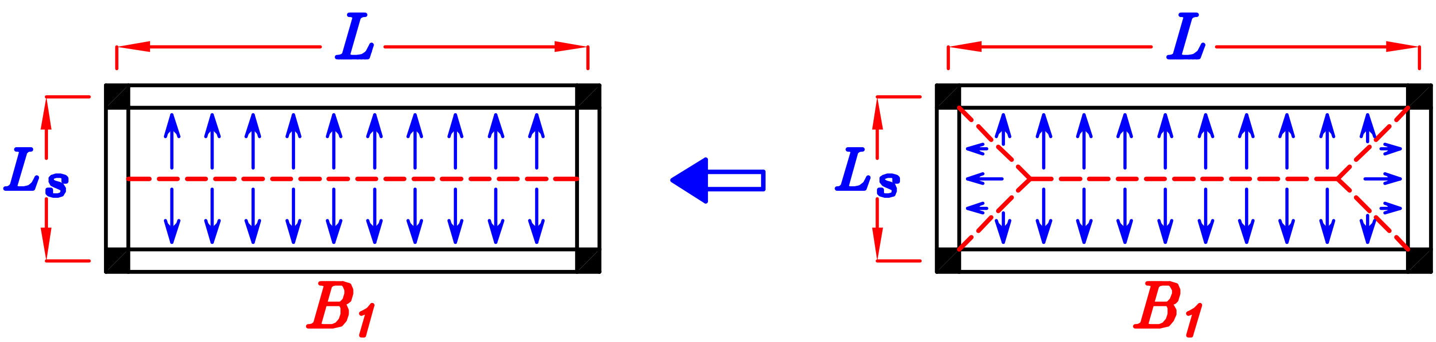


عند تصنيف الزوايا بين الكمرات

سيظهر أن الكمره الطويله تحمل نسبه كبيره جدا من الحمل

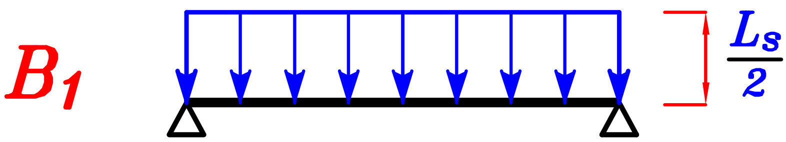
و الكمره القصيره تحمل جزء قليل جدا من الحمل

لذا نعتبرها بلاطه **One way** فى الاتجاه الاقصر فقط.

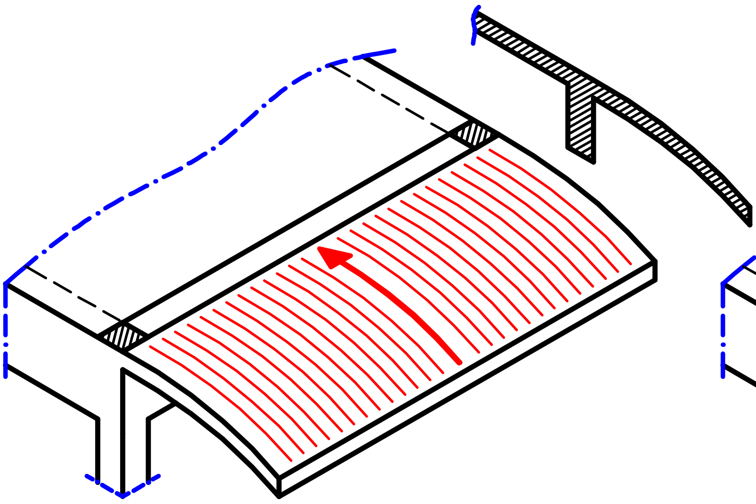


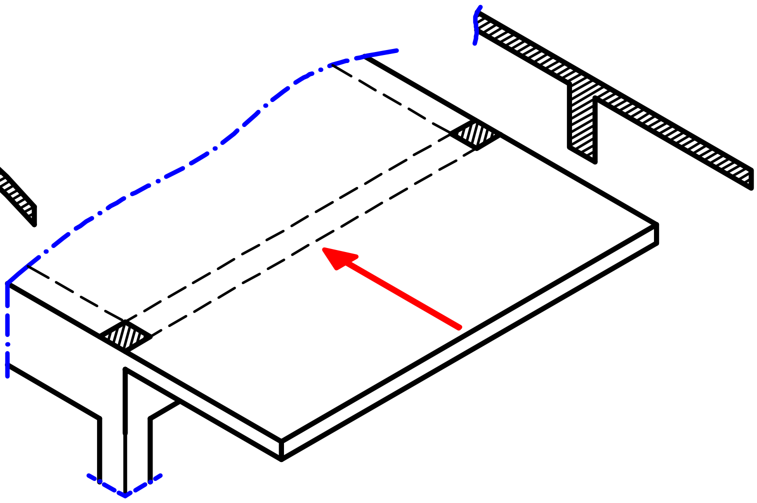
توزيع الحمل فى البلاطات ال **One way** ذات ال **٤ كمرات**

يكون بعمل خط موازى للكمرتين الاطول .

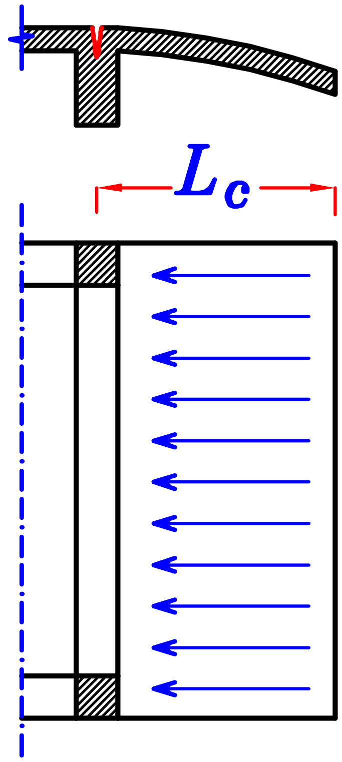


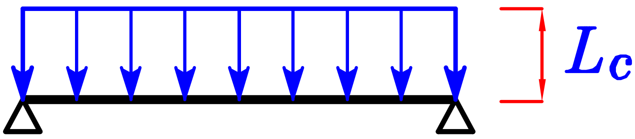
3 - For Cantilever Slabs .

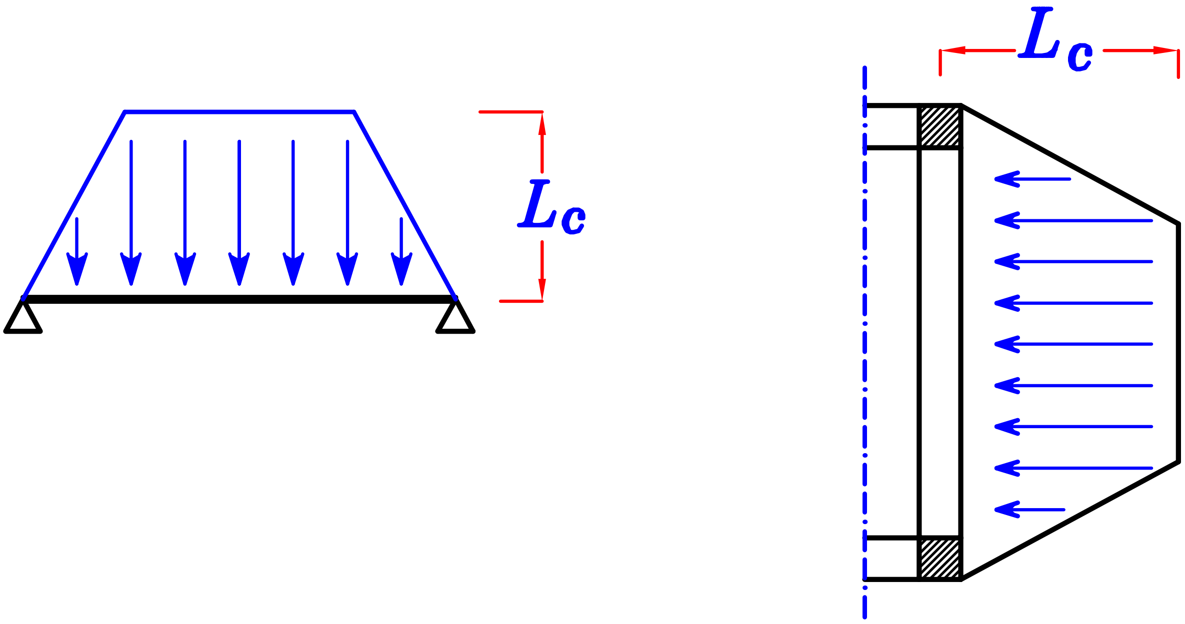




لان البلاطه الـ Cantilever محموله بالكامل على الكمره
فلا يوجد توزيع للاحمال انما البلاطه كلها محموله على نفس الكمره

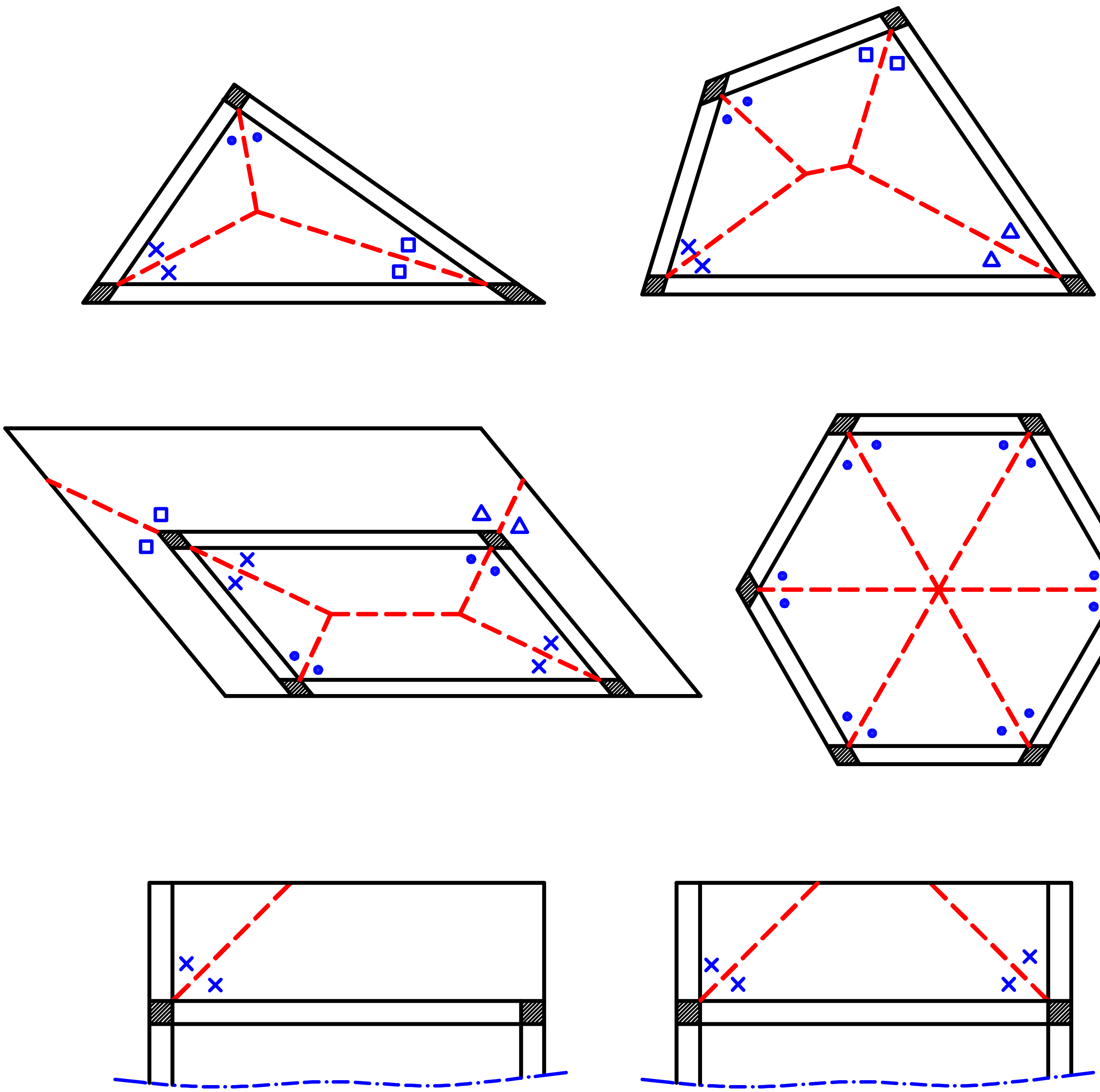






4- For Irregular Slabs .

لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات

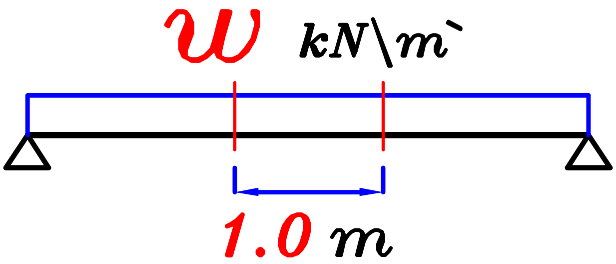


Calculation of loads on Beams.

لكى نصمم الكمره لاحقا يجب أن نرسم أولاً **B.M.D. & S.F.D.**

و لكى نرسم **B.M.D. & S.F.D.** يجب أولا أن نحسب قيمه (w).

حيث (w) هى الحمل الموجود على الكمره فى المتر الطولى الواحد .



$w =$ O.W. of the beam + Weight of the wall + Weight From the slab.

$$\boxed{w = o.w._{(beam)} + walls + Slabs = \checkmark \ kN\backslash m`}$$

أى أن الوزن الواقع على الكمره يتكون من ثلاث أشياء :

① o.w. of the beam.

١ـ وزن الكمره نفسـها . (وزن متر طولى من الكمره).

② Weight of walls.

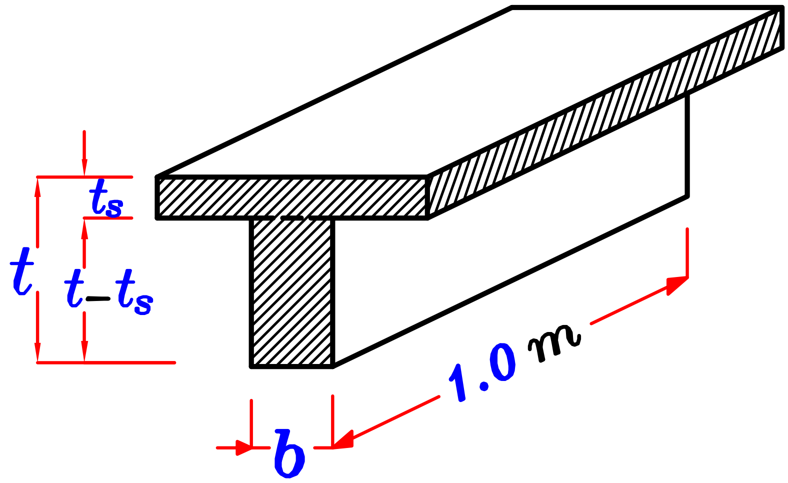
٢ـ وزن الحوائط التى تحملها الكمره . (وزن متر طولى من الحائط).

③ Loads From the slab.

٣ـ وزن البلاطه الواقع على الكمره . (وزن البلاطه المحمول على متر طولى من الكمره).

① o.w. of the beam (own weight)

نحسب وزن الكمره فى المتر الطولى



$$\boxed{\text{Density of R.C. } (\gamma_c) = 25 \ kN\backslash m^3}$$

$$o.w._{(beam)} = \text{Volume} * \text{Density}$$

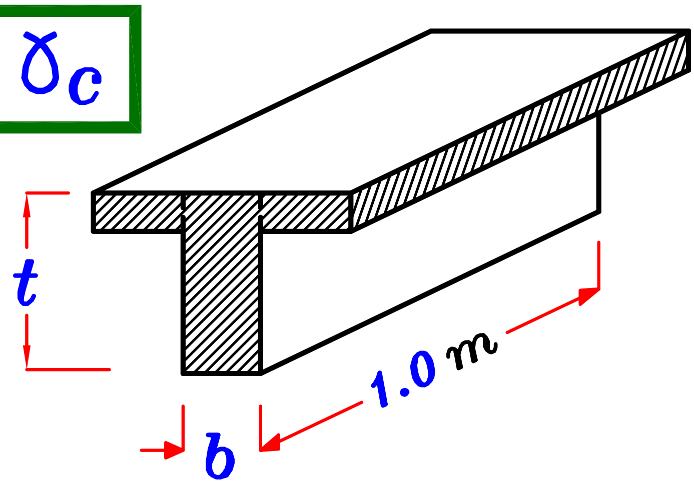
$$= \left[(b)(t-t_s)(1.0)\right] * \gamma_c$$

$$\boxed{o.w._{(beam)} = (b)\ (t-t_s)\ \gamma_c} \quad kN\backslash m'$$

و لكن للتسهيل و فى نفس الوقت more safe

سنأخذ وزن المتر الطولى من الكمره

$$\boxed{o.w._{(beam)} = (b)\ (t)\ \gamma_c}$$



ملاحظات :

١ـ إذا كانت أبعاد الكمره معروفه $(b * t)$

Example.

$(250 * 600) \longrightarrow b = 250\ mm = 0.25\ m\ ,\quad t = 600\ mm = 0.60\ m$

نحسب وزن المتر الطولى كما سبق :

$$o.w._{(beam)} = (b)\,(t)\,\gamma_c = (0.25)\,(0.60)\,(25) = 3.75\ kN\backslash m`$$

Example.

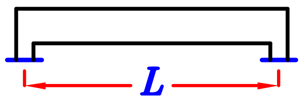
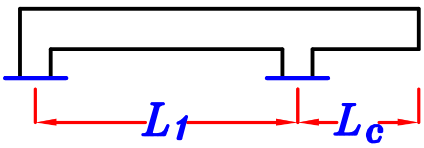
٢ـ لو الوزن معطى مباشره (تم فرضه) :

Take $o.w._{(beam)} = 3.0\ kN\backslash m`$

و فى هذه الحالة لا نحسب قيمه الـ $o.w.$
بل نأخذ القيمه المُعطاه مباشره .

٣ـ من الممكن ان تكون ابعاد الكمره غير معطاه فنفرضها كالتالى :

Take $b = 250\ mm$

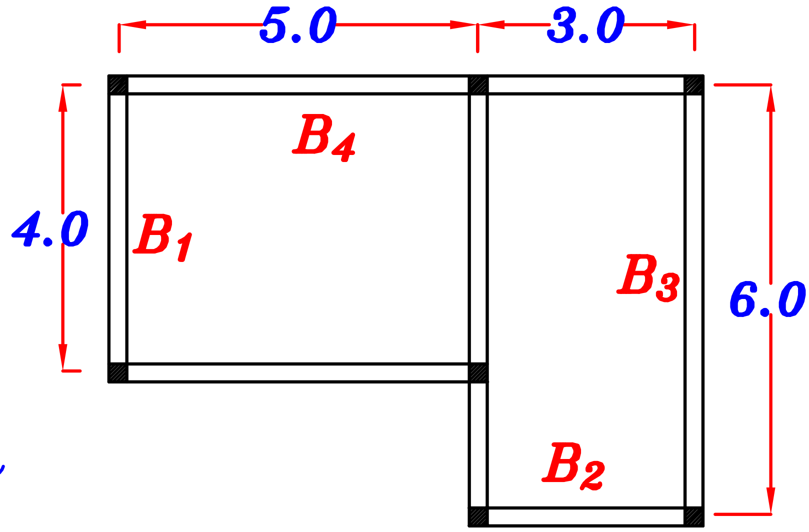
Type of beam	Thickness (t)
Simple Beam 	$t = \dfrac{L}{10}$
Continuos Beam 	$t = \dfrac{L_{bigger}}{12}$
Beam with Cantilever 	$t = \left.\begin{matrix}\dfrac{L_1}{12}\\ \dfrac{L_c}{5}\end{matrix}\right\}$ الأكبر

و تقرب (t) لأقرب ٥٠ مم بالزياده .

و أقل (t) للكمره = ٤٠٠ مم (٤٠ سم) $\quad t_{min} = 400\ mm$

Example.

Estimate the thickness of the beams.

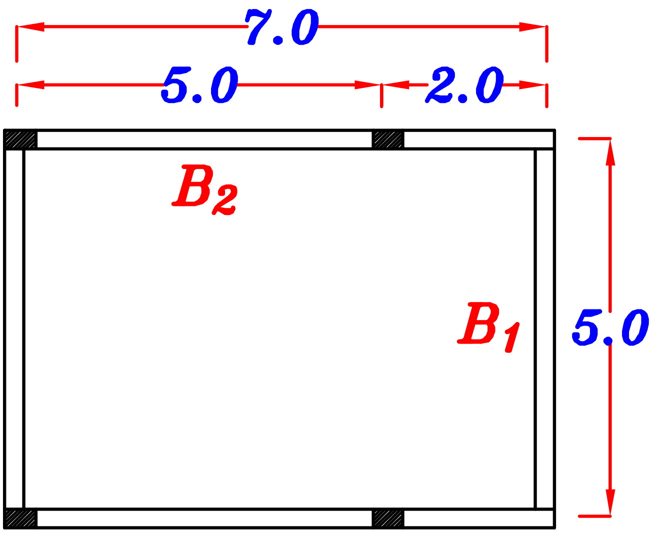


B1 $t_1 = \frac{4}{10} = 0.40\ m$

B2 $t_2 = \frac{3}{10} = 0.3\ m < 0.40\ m \quad \therefore t_2 = 0.4\ m$

B3 $t_3 = \frac{6}{10} = 0.60\ m$

B4 $t_4 = \frac{5}{12} = 0.416\ m = 0.45\ m$



B1 $t_1 = \frac{5}{10} = 0.50\ m$

B2 $t_2 = \left.\begin{array}{l} \frac{5}{12} = 0.416\ m \\ \frac{2}{5} = 0.40\ m \end{array}\right\}$

$= 0.416\ m = 0.45\ m$

But B1 supported on B2

$\therefore$ Take $t_2 = t_1 = 0.50\ m$

② Weight of walls.

وزن الحائط فى المتر الطولى

١- إذا كان المعطى هو $(\gamma_w = \checkmark\ kN\backslash m^3)$ أى كثافة الحائط .

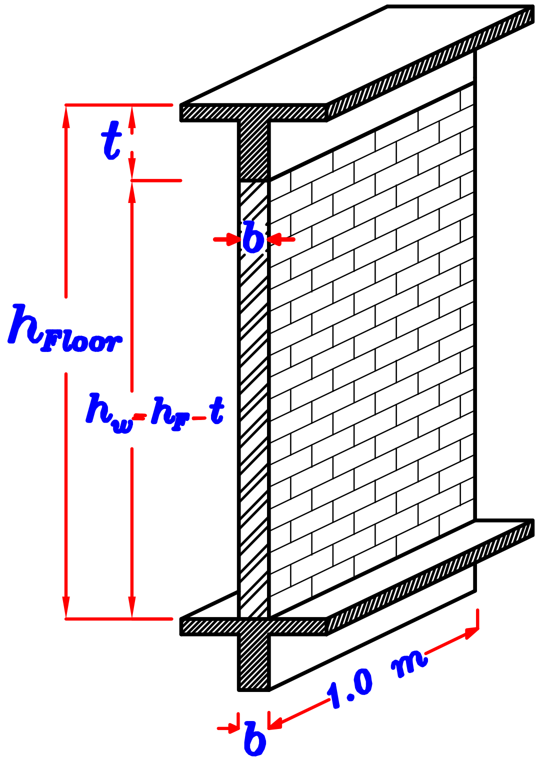
$$\boxed{\gamma_w = \checkmark\ kN\backslash m^3}$$

$$(w)_w = Volume * Density$$

$$= (b * h_w * 1.0)\ \gamma_w$$

$$= \checkmark\ kN\backslash m'$$

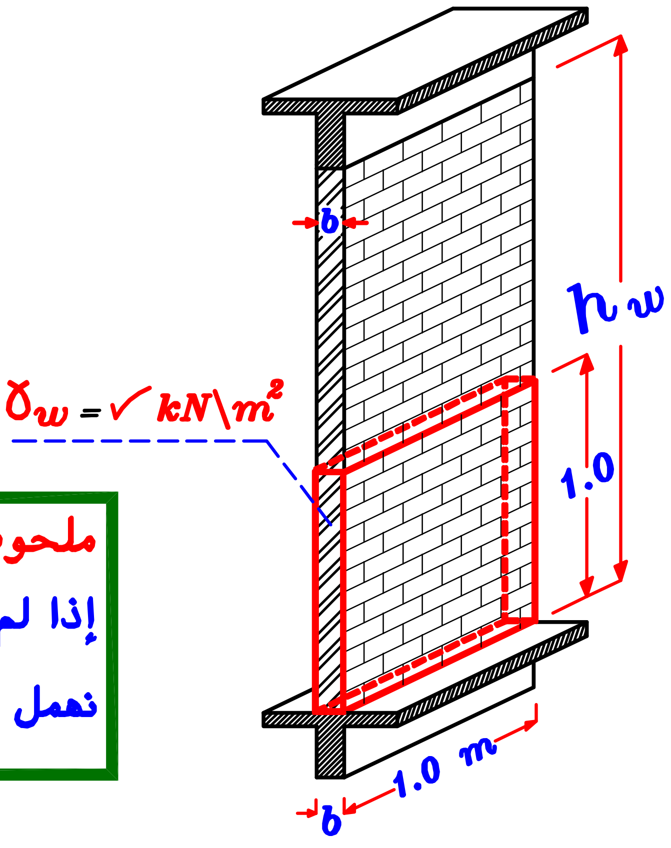
$$\boxed{(w)_w = b * h_w * \gamma_w}$$



٢- إذا كان المعطى هو $(\gamma_w = \checkmark\ kN\backslash m^2)$ أى وزن المتر المربع من الحائط .

$$\boxed{\gamma_w = \checkmark\ kN\backslash m^2}$$

$$\boxed{(w)_w = h_w * \gamma_w}$$

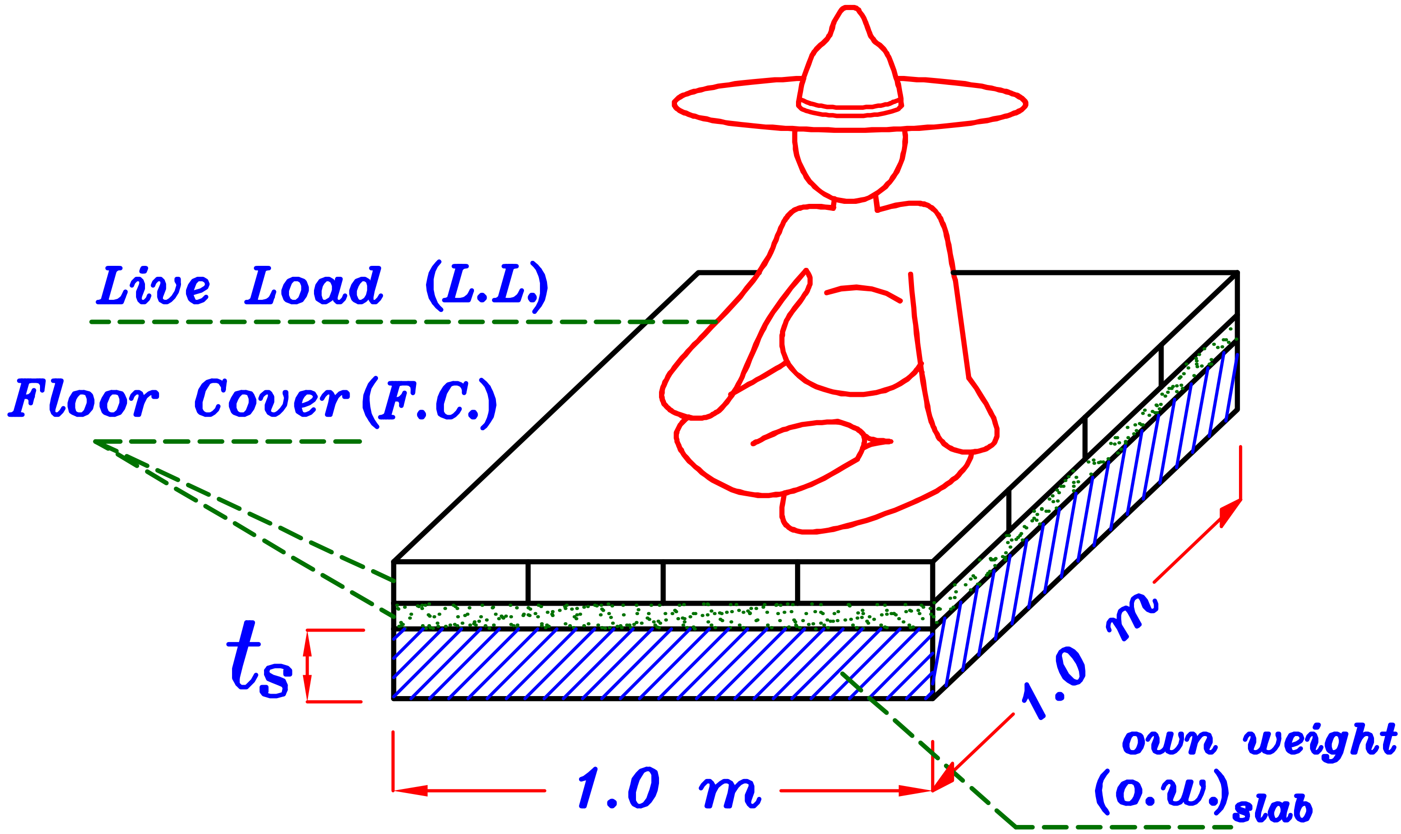


ملحوظة

إذا لم يعطينا أى معلومات عن الحائط نهمل وجوده $\boxed{(w)_w = Zero}$

③ Loads From slab.

حمل البلاطه يذهب إلى الكمره .
و توزيع هذا الحمل يتوقف على نوع البلاطه و عدد الكمرات .
و لكى نحسب حمل البلاطه الذاهب إلى الكمره
يجب أولاً أن نحدد الحمل على البلاطه (الحمل على ١,٠ م٢ من البلاطه)
و هذا الحمل يتكون من ثلاثة أشياء :



ⓐ Own Weight of the slab. (o.w.)

نحسب وزن البلاطه لـ ١,٠ م٢ فقط

$$(o.w.)_{slab} = Volume * Density$$

$$= (t_s * 1.0 * 1.0)\ \gamma_c = \checkmark\ kN\backslash m^2$$

$$\boxed{(o.w.)_{slab} = t_s * \gamma_c} \quad (kN\backslash m^2)$$

ⓑ Floor Cover. (F.C.)

هو وزن الأرضيه + الرمل.

و يتوقف على نوع الأرضيه (خشب باركيه أو بلاط أو سيراميك ...... ألخ).

و إذا لم يذكر أى معلومات عن نوع الأرضيه نأخذ $\boxed{F.C. = 1.50 \ kN\backslash m^2}$

ⓒ Live Load. (L.L.)

و هى الأحمال الحيه التى ممكن أن تتحرك أو يتغير مكانها

مثل (الناس أو الأثاث ...... ألخ)

و تختلف قيمه الأحمال الحيه حسب إختلاف إستعمال المنشأ و هى كالأتى :

مبنى سكنى ⟵ $L.L. = 2.0 \quad kN\backslash m^2$

مبنى إدارى أو مدرسه ⟵ $L.L. = 3.0 \quad kN\backslash m^2$

سينما أو مسرح ⟵ $L.L. = 5.0 \quad kN\backslash m^2$

مكتبه أو مخزن ⟵ $L.L. = 10.0 \quad kN\backslash m^2$

فى البيوت السكنيه غالباً يكون L.L. $\boxed{L.L. = 2.0 \ kN\backslash m^2}$

Load of 1.0 m^2 of the slab. (w_s)

(w_s) هى الوزن الواقع على ١,٠ م٢ من البلاطه

$$w_s = D.L. + L.L. = (o.w. + F.C.) + L.L.$$

$$= (t_s * \gamma_c + F.C.) + L.L.$$

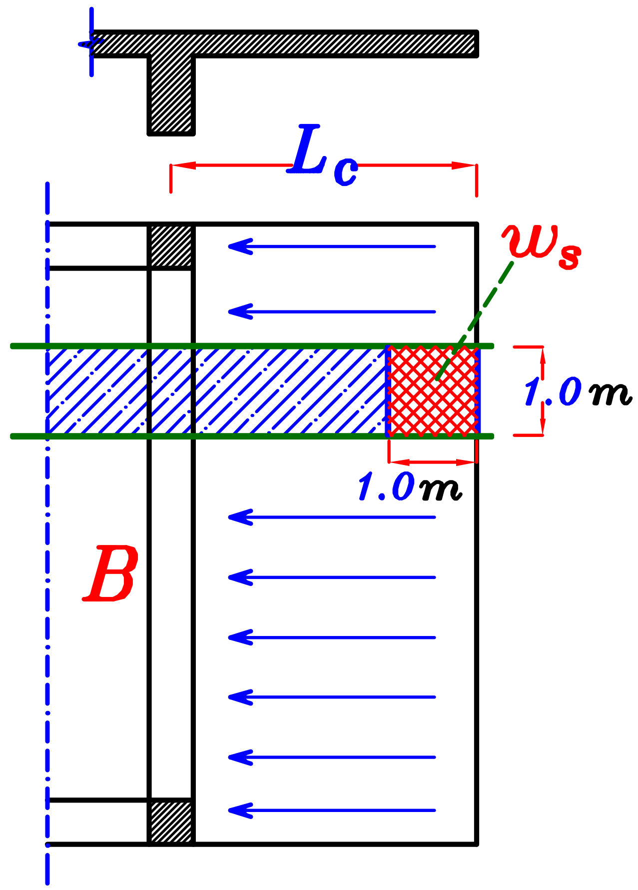
$$\boxed{w_s = t_s * \gamma_c + F.C. + L.L.} \quad (kN\backslash m^2)$$

بعد تحديد وزن البلاطه فى المتر المربع w_s .

نحدد حمل البلاطه الواقع على الكمره .

حيث يتوقف هذا الحمل على نوع البلاطه و عدد الكمرات .

1 Cantilever Slab.

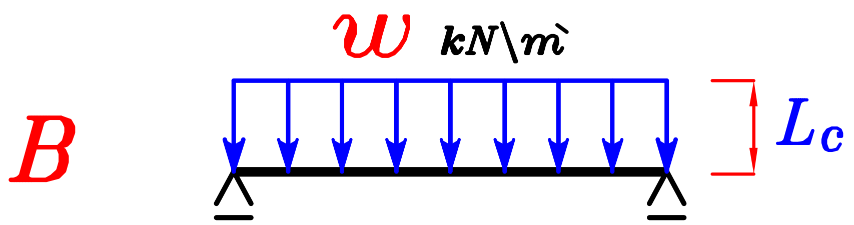


∵ الحمل على المتر المربع من البلاطه $= w_s$

∵ الكمره تحمل طول من البلاطه $= L_c$

∴ الوزن على المتر الطولى من الكمره $= w$

$$\boxed{w = o.w._{(beam)} + walls + w_s\, L_c} \quad kN\backslash m`$$



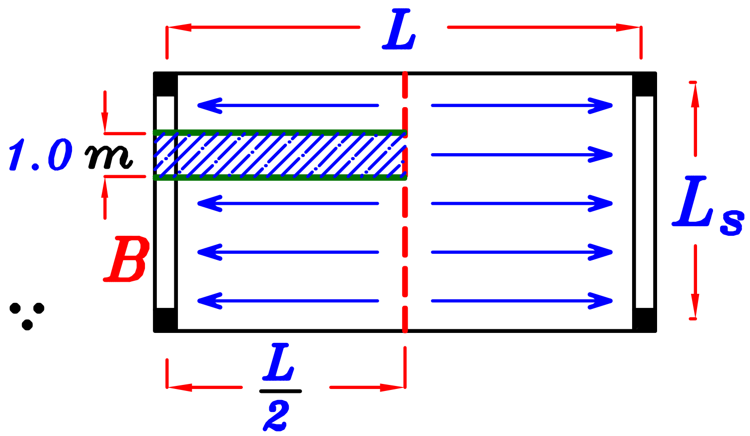
② One Way Slab.

ال One Way Slab هى عباره عن بلاطه يسير فيها الحمل فى إتجاه واحد فقط.

يوجد نوعان للبلاطات ال One Way .

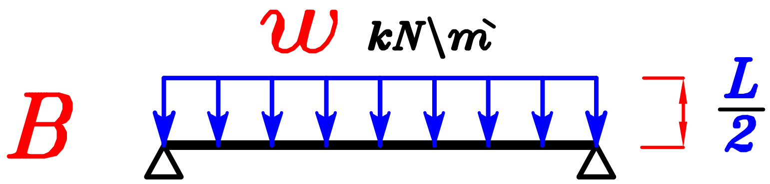
ⓐ Two beams only.

1- (Long Direction)

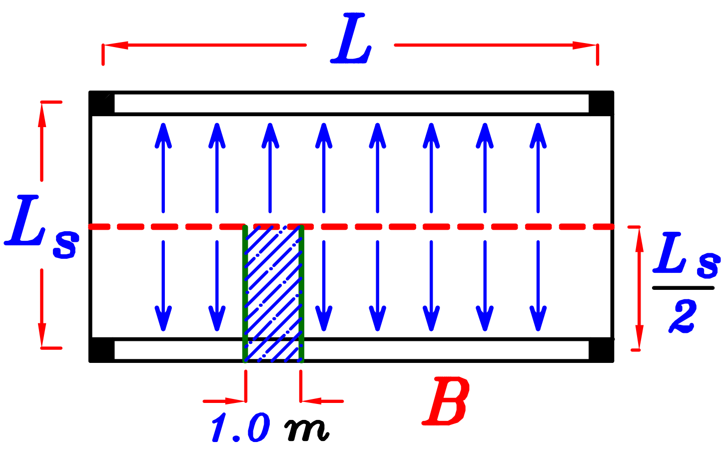


∵ الكمره تحمل طول من البلاطه = $\frac{L}{2}$

$$\boxed{w = o.w._{(beam)} + walls + w_s \frac{L}{2}} \; kN\backslash m`$$

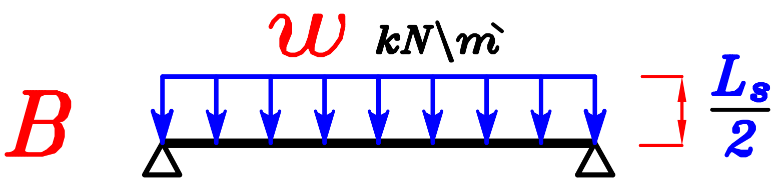


2- (Short Direction)



∵ الكمره تحمل طول من البلاطه = $\frac{L_s}{2}$

$$\boxed{w = o.w._{(beam)} + walls + w_s \frac{L_s}{2}} \; kN\backslash m`$$



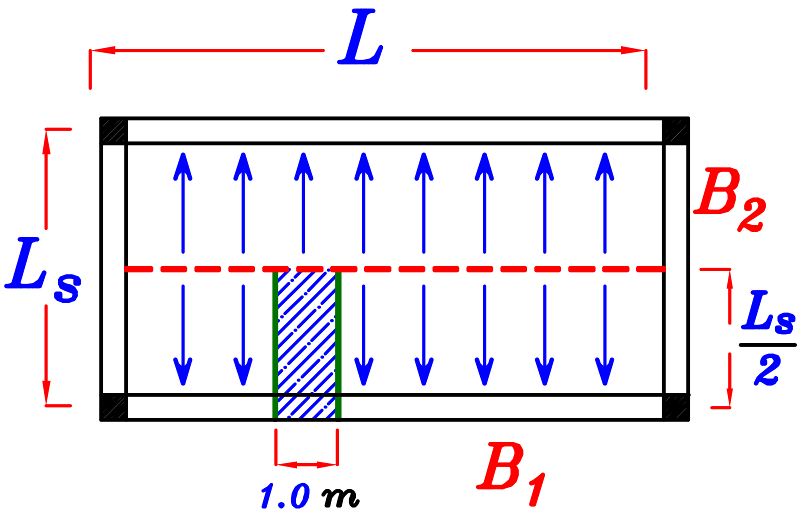
ⓑ Four beams.

شرط لكى تكون البلاطه One Way Slab

و بها ٤ كمرات يجب أن يكون $\boxed{\frac{L}{L_s} > 2.0}$

L = Longer Length

L_s = Shorter Length

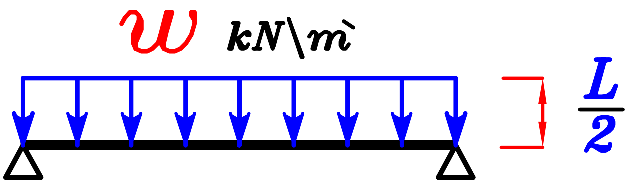


B_1

الكمره تحمل طول $\frac{L_s}{2}$ من البلاطه

$$\boxed{w = o.w._{(beam)} + walls + w_s \frac{L_s}{2}} \quad kN\backslash m'$$

B_1

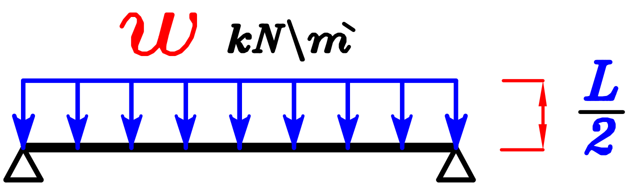


B_2

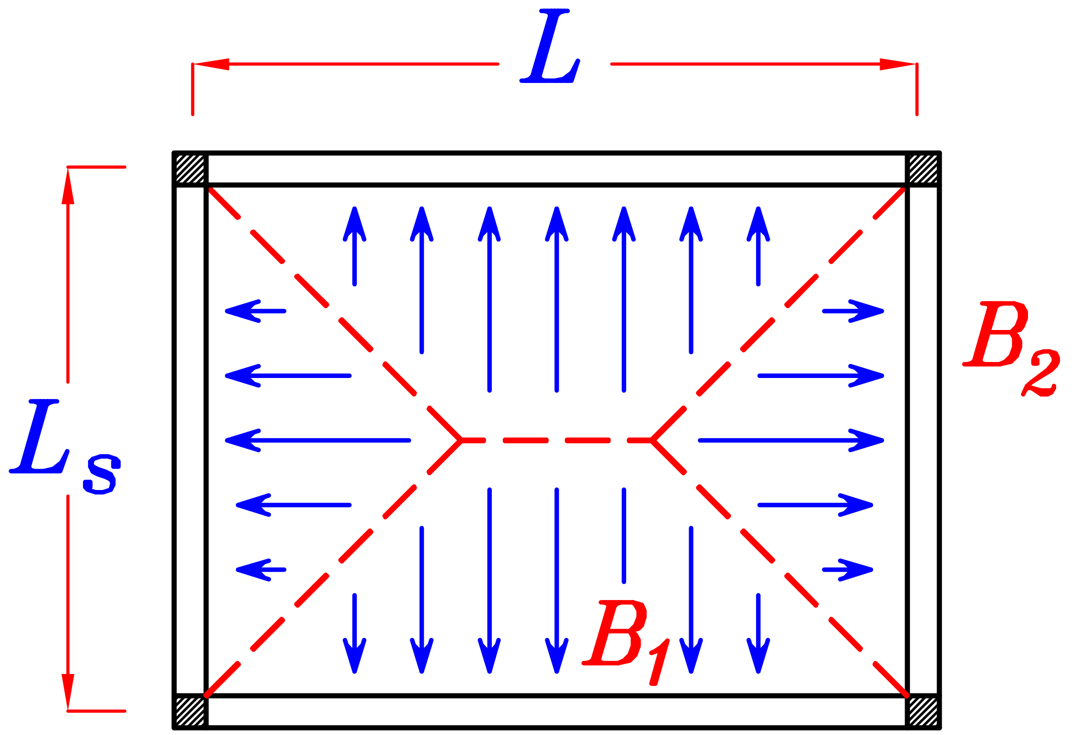
الكمره لا تحمل أى شيئ من البلاطه

$$\boxed{w = o.w._{(beam)} + walls} \quad kN\backslash m'$$

B_2



③ Two Way Slab.

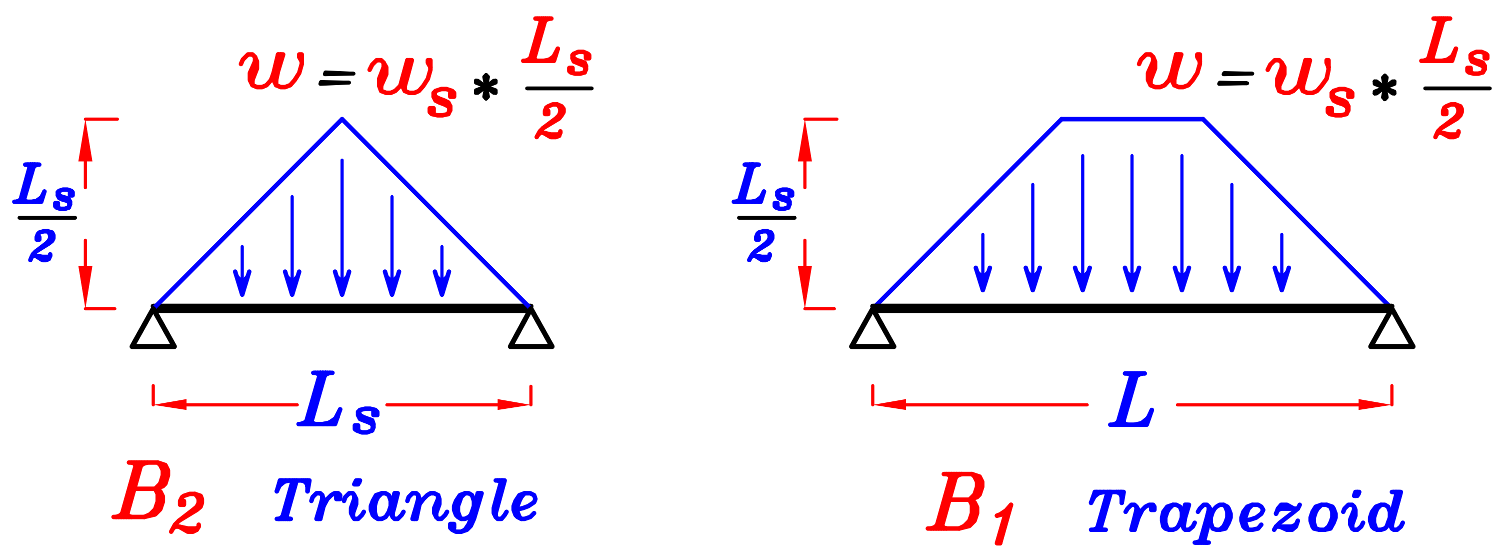


البلاطات الـ Two way تكون محموله على ٤ كمرات

و يجب أن يكون $\boxed{\frac{L}{L_s} \leqslant 2.0}$

و يذهب الحمل على شكل مثلث إلى الكمره القصيره .

و على شكل شبة منحرف إلى الكمره الطويله .



و لكى نستطيع أن نصمم هذه الكمرات يجب أن نحسب الـ ***shear* , *moment***

لذلك نحول هذه الأشكال إلى شكل مستطيل ***uniform Load***

و ذلك بأن نضرب قيمة w (حيث $w = w_s * \frac{L_s}{2}$) فى ***Factor*** مثل C_a

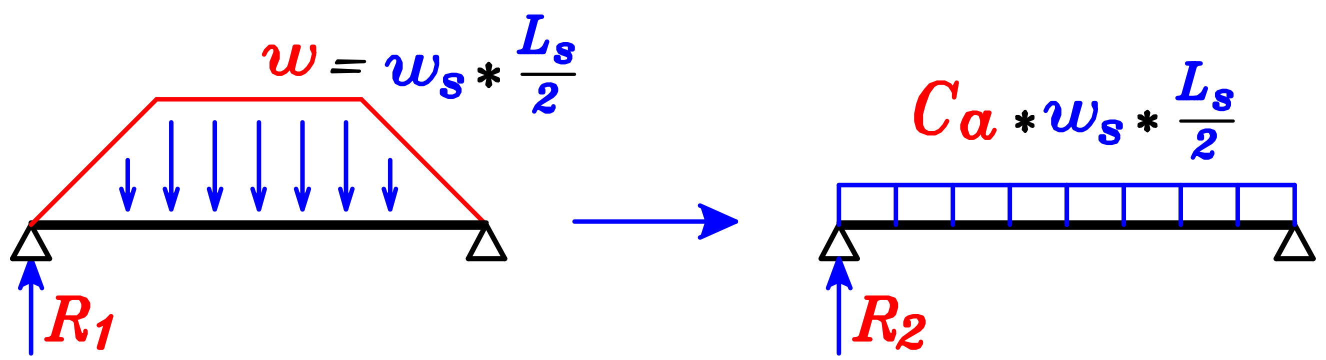
لكى يعطى ***Reaction*** مساوى للـ ***Reaction*** الموجود فى الأشكال الأخرى.

و أن نضرب w (حيث $w = w_s * \frac{L_s}{2}$) فى ***Factor*** مثل C_e

لكى يعطى ***moment*** مساوى لأكبر ***moment*** موجود فى الأشكال الأخرى.

* لتحديد قيم الـ C_a

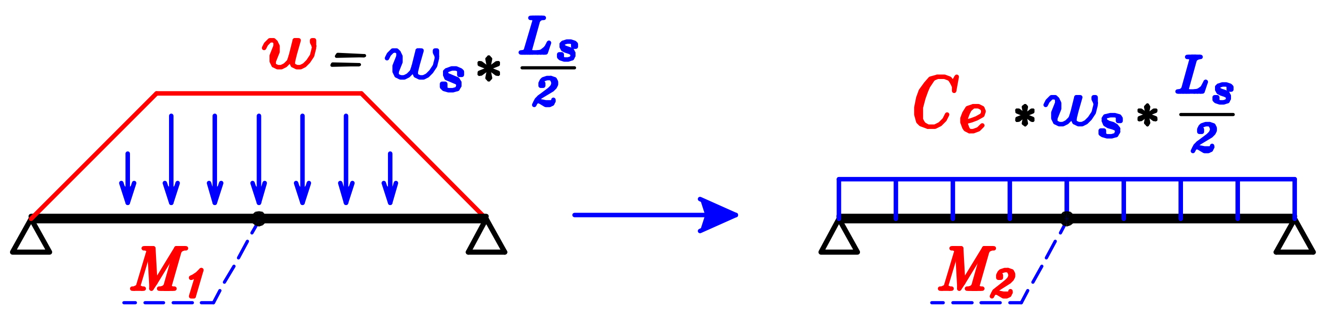
نساوى ***Reaction*** الحمل الاصلى R_1 بـ ***Reaction*** الحمل المكافىء R_2



$$\boxed{R_1 = R_2 \longrightarrow C_a = \checkmark}$$

* لتحديد قيم الـ C_e

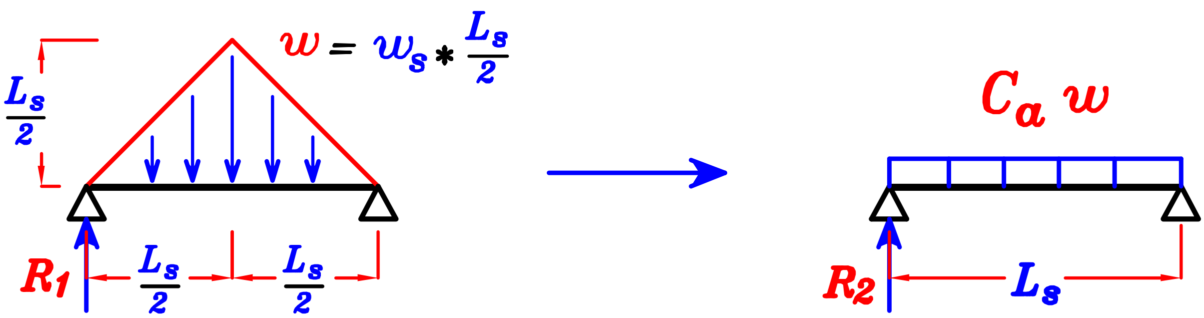
نساوى ***moment*** الحمل الاصلى M_1 بـ ***moment*** الحمل المكافىء M_2



$$\boxed{M_1 = M_2 \longrightarrow C_e = \checkmark}$$

Triangular Load on Simple Span.

① Load For Shear.

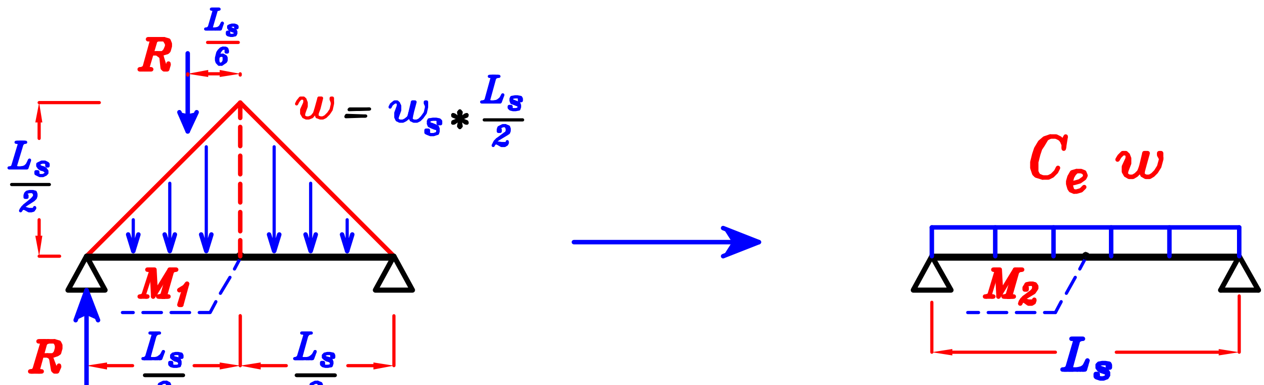


$$R_1 = \frac{Total\ \ Load}{2} = \frac{(1\backslash 2) * w * L_s}{2} = \frac{w * L_s}{4}$$

$$R_2 = \frac{(C_a * w) * L_s}{2}$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w} * \cancel{L_s}}{4} = \frac{(C_a * \cancel{w}) * \cancel{L_s}}{2} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.



$$R = \frac{Total\ \ Load}{2} = \frac{(1\backslash 2) * w * L_s}{2} = \frac{w * L_s}{4}$$

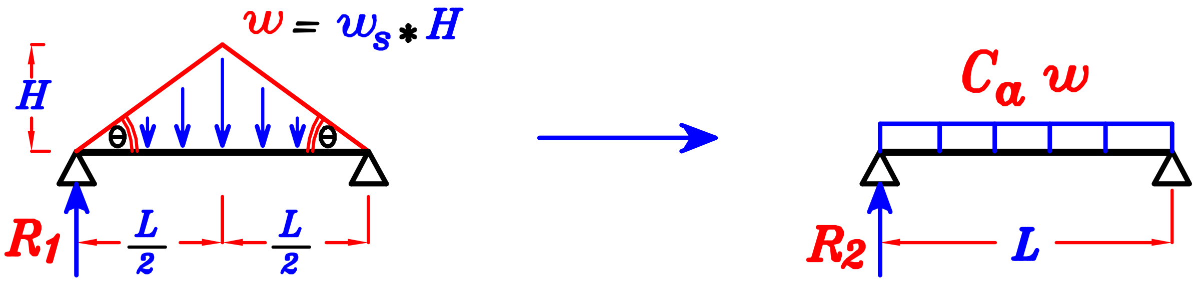
$$M_1 = R * \frac{L_s}{2} - R * \frac{L_s}{6} = R * \frac{L_s}{3} = \frac{w * L_s}{4} * \frac{L_s}{3} = \frac{w * L_s^2}{12}$$

$$M_2 = \frac{(C_e * w) * L_s^2}{8}$$

$$\because M_1 = M_2 \quad \therefore \frac{\cancel{w} * \cancel{L_s^2}}{12} = \frac{(C_e * \cancel{w}) * \cancel{L_s^2}}{8} \longrightarrow \boxed{C_e = \frac{2}{3}}$$

Triangular Load with equal angles.

① Load For Shear.

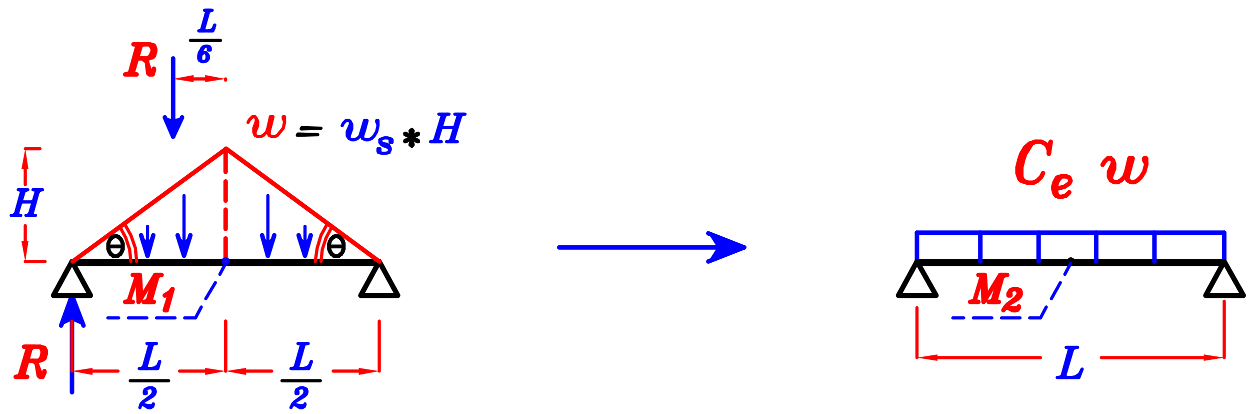


$$R_1 = \frac{Total\ Load}{2} = \frac{(1\backslash 2) * w * L}{2} = \frac{w * L}{4}$$

$$R_2 = \frac{(C_a * w) * L}{2}$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w} * \cancel{L}}{4} = \frac{(C_a * \cancel{w}) * \cancel{L}}{2} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.



$$R = \frac{Total\ Load}{2} = \frac{(1\backslash 2) * w * L}{2} = \frac{w * L}{4}$$

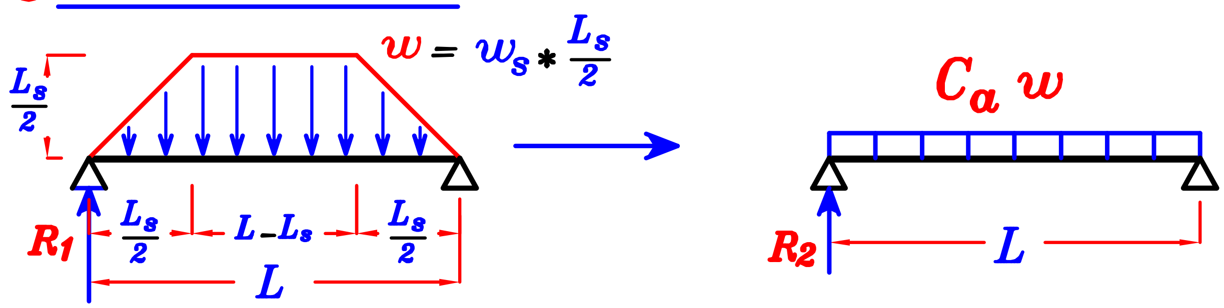
$$M_1 = R * \frac{L}{2} - R * \frac{L}{6} = R * \frac{L}{3} = \frac{w * L}{4} * \frac{L}{3} = \frac{w * L^2}{12}$$

$$M_2 = \frac{(C_e * w) * L^2}{8}$$

$$\because M_1 = M_2 \quad \therefore \frac{\cancel{w} * \cancel{L}^2}{12} = \frac{(C_e * \cancel{w}) * \cancel{L}^2}{8} \longrightarrow \boxed{C_e = \frac{2}{3}}$$

Trapezoidal Load on Simple Span.

① Load For Shear.

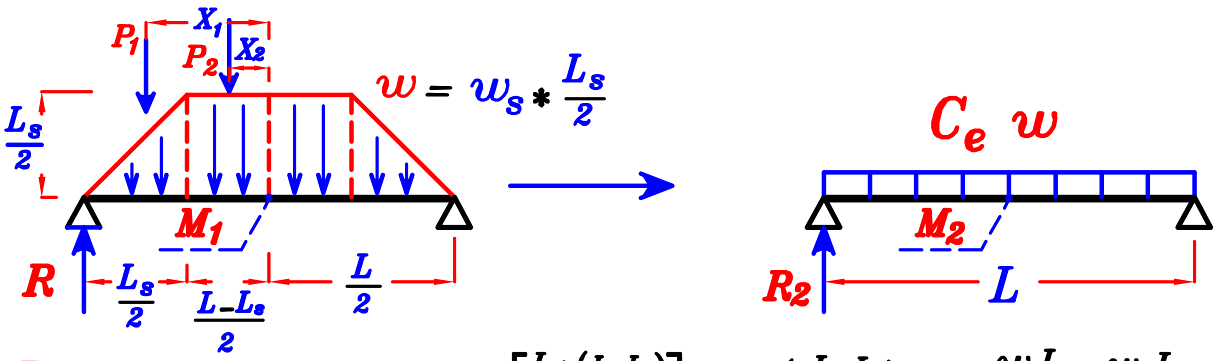


$$R_1 = (1\backslash 2)\ \text{Total Load} = (1\backslash 2)\left[\frac{L+(L-L_s)}{2}\right] w = \left(\frac{2L-L_s}{4}\right) w = \frac{w\,L}{2} - \frac{w\,L_s}{4}$$

$$R_2 = \frac{(C_a * w) * L}{2}$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w}\,L}{2} - \frac{\cancel{w}\,L_s}{4} = \frac{(C_a * \cancel{w}) * L}{2} \longrightarrow \boxed{C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right)}$$

② Load For Moment.



$$R = (1\backslash 2)\ \text{Total Load} = (1\backslash 2)\left[\frac{L+(L-L_s)}{2}\right] w = \left(\frac{2L-L_s}{4}\right) w = \frac{w\,L}{2} - \frac{w\,L_s}{4}$$

$$P_1 = (1\backslash 2) * w * \frac{L_s}{2} = \frac{w * L_s}{4} \quad , \quad X_1 = \frac{L-L_s}{2} + \frac{L_s}{6} = \frac{L}{2} - \frac{L_s}{3}$$

$$P_2 = w\left(\frac{L-L_s}{2}\right) = \frac{w\,L}{2} - \frac{w\,L_s}{2} \quad , \quad X_2 = \frac{L-L_s}{4} = \frac{L}{4} - \frac{L_s}{4}$$

$$M_1 = R * \frac{L}{2} - P_1 * X_1 - P_2 * X_2$$

$$M_1 = \left(\frac{w\,L}{2} - \frac{w\,L_s}{4}\right) * \frac{L}{2} - \left(\frac{w * L_s}{4}\right)\left(\frac{L}{2} - \frac{L_s}{3}\right) - \left(\frac{w\,L}{2} - \frac{w\,L_s}{2}\right)\left(\frac{L}{4} - \frac{L_s}{4}\right)$$

$$= \frac{w\,L^2}{4} - \frac{w\,L\,L_s}{8} - \frac{w\,L\,L_s}{8} + \frac{w\,L_s^2}{12} - \frac{w\,L^2}{8} + \frac{w\,L\,L_s}{8} + \frac{w\,L\,L_s}{8} - \frac{w\,L_s^2}{8}$$

$$= \left(\frac{w\,L^2}{4} - \frac{w\,L^2}{8}\right) + \left(\frac{w\,L_s^2}{12} - \frac{w\,L_s^2}{8}\right) = \frac{w\,L^2}{8} - \frac{w\,L_s^2}{24}$$

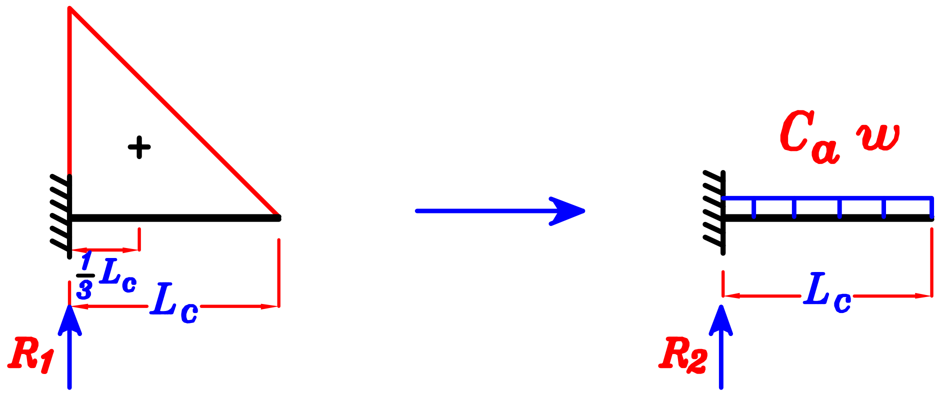
$$\because M_1 = M_2 \quad \therefore \frac{\cancel{w}\,L^2}{8} - \frac{\cancel{w}\,L_s^2}{24} = \frac{(C_e * \cancel{w}) * L^2}{8} \qquad \therefore L^2 - \frac{L_s^2}{3} = C_e * L^2$$

Divide by (L^2) $\quad \therefore C_e = \frac{1}{3}\left(3 - \frac{L_s}{L}\right)^2 \longrightarrow \boxed{C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2}$

Triangular Load on Cantilever.

① Load For Shear.

$w = w_s * L_c$



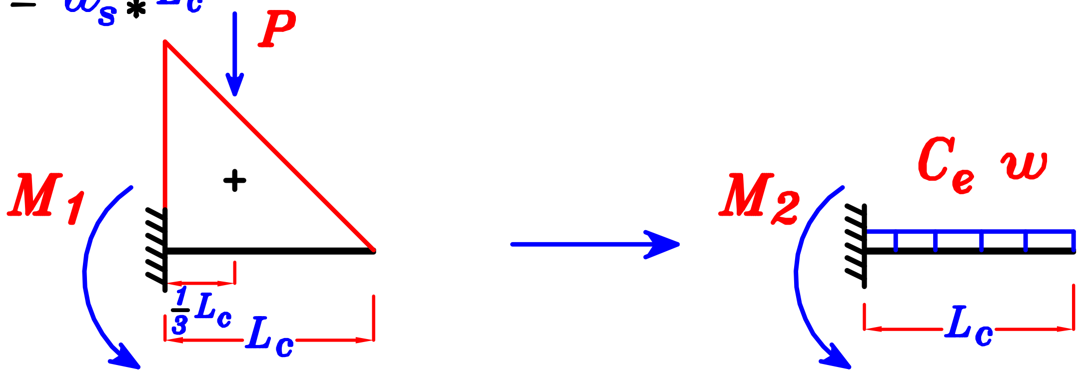
$$R_1 = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$R_2 = (C_a * w) * L_c$$

$$\because R_1 = R_2 \quad \therefore \frac{w * \cancel{L_c}}{2} = (C_a * \cancel{w}) * \cancel{L_c} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.

$w = w_s * L_c$



$$P = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

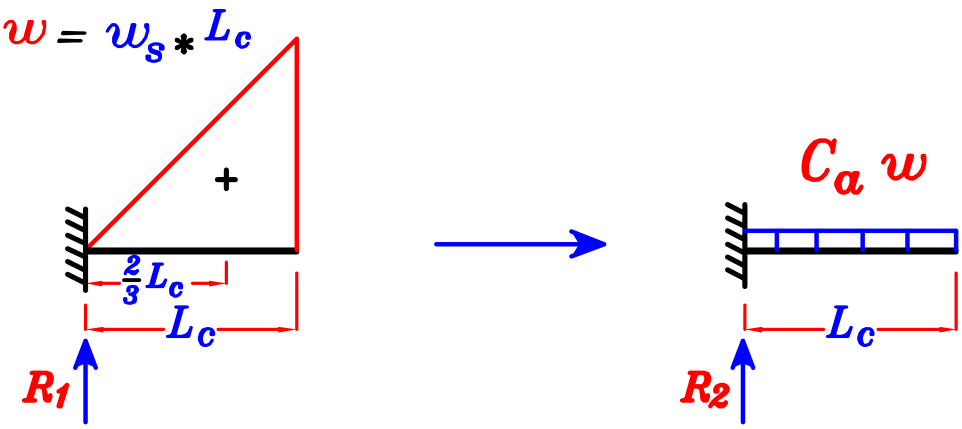
$$M_1 = P * \frac{1}{3} L_c = \frac{w * L_c}{2} * \frac{1}{3} L_c = \frac{w * L_c^2}{6}$$

$$M_2 = \frac{(C_e * w) * L_c^2}{2}$$

$$\because M_1 = M_2 \quad \therefore \frac{w * L_c^2}{6} = \frac{(C_e * w) * L_c^2}{2} \longrightarrow \boxed{C_e = \frac{1}{3}}$$

Triangular Load on Cantilever.

① Load For Shear.

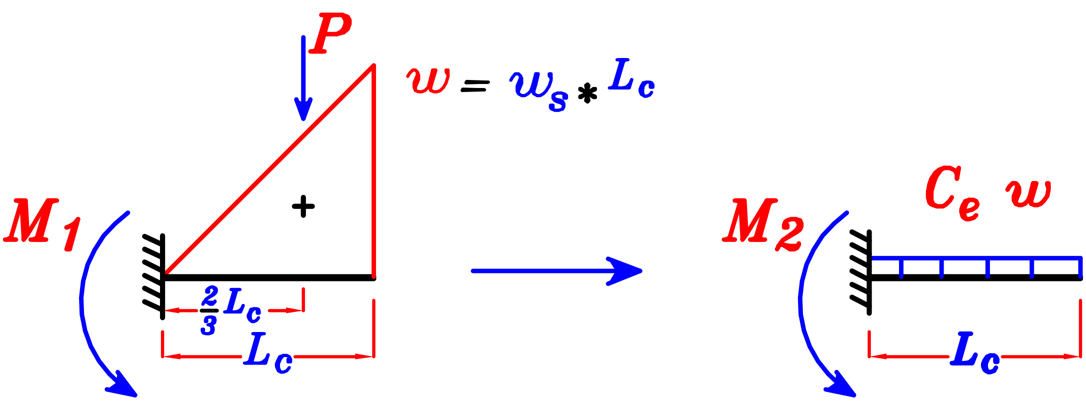


$$R_1 = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$R_2 = (C_a * w) * L_c$$

$$\because R_1 = R_2 \qquad \therefore \frac{\cancel{w} * \cancel{L_c}}{2} = (C_a * \cancel{w}) * \cancel{L_c} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.



$$P = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

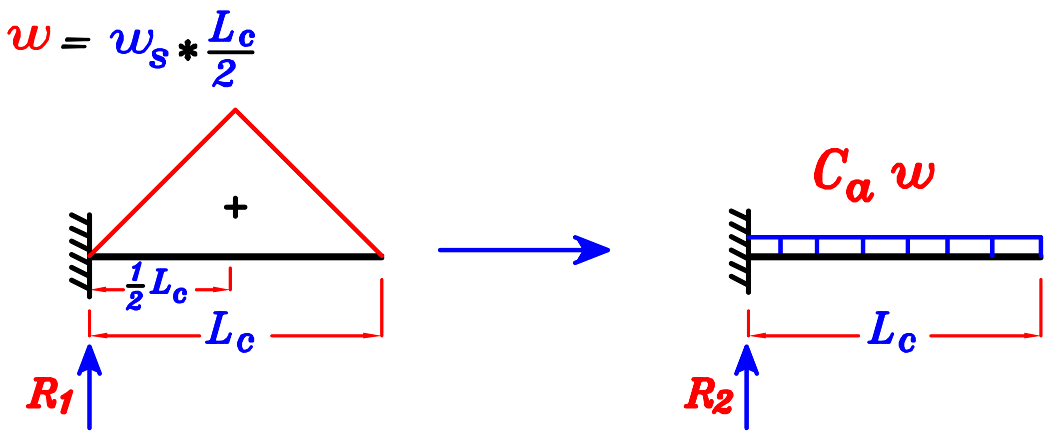
$$M_1 = P * \frac{2}{3} L_c = \frac{w * L_c}{2} * \frac{2}{3} L_c = \frac{w * L_c^2}{3}$$

$$M_2 = \frac{(C_e * w) * L_c^2}{2}$$

$$\because M_1 = M_2 \qquad \therefore \frac{w * L_c^2}{3} = \frac{(C_e * w) * L_c^2}{2} \longrightarrow \boxed{C_e = \frac{2}{3}}$$

Triangular Load on Cantilever.

① Load For Shear.

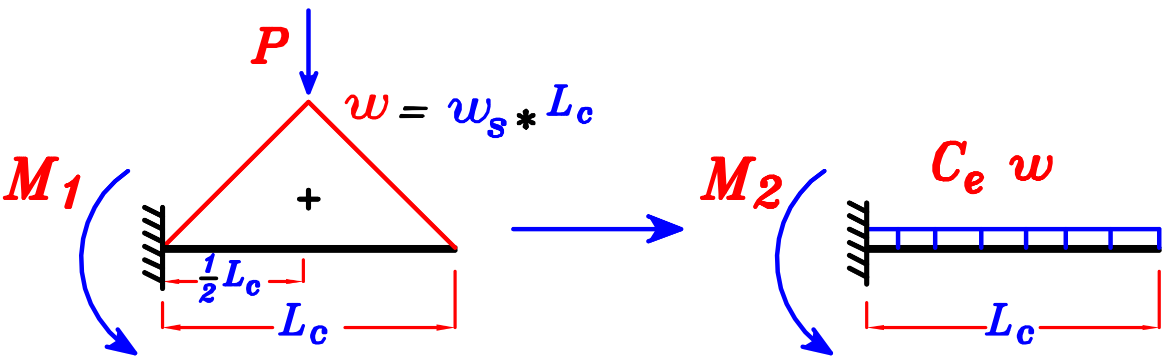


$$R_1 = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$R_2 = (C_a * w) * L_c$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w} * \cancel{L_c}}{2} = (C_a * \cancel{w}) * \cancel{L_c} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.



$$P = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$M_1 = P * \frac{1}{2} L_c = \frac{w * L_c}{2} * \frac{1}{2} L_c = \frac{w * L_c^2}{4}$$

$$M_2 = \frac{(C_e * w) * L_c^2}{2}$$

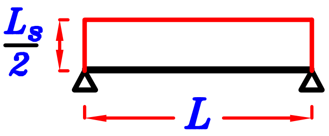
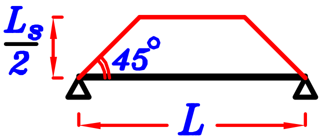
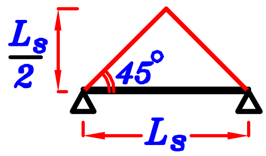
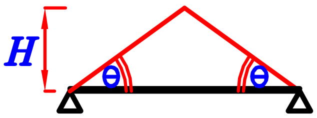
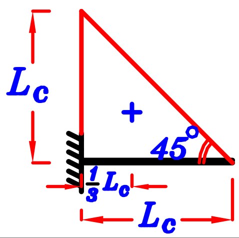
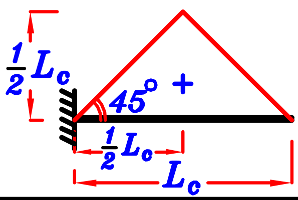
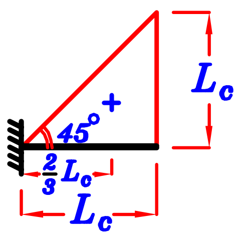
$$\because M_1 = M_2 \quad \therefore \frac{w * L_c^2}{4} = \frac{(C_e * w) * L_c^2}{2} \longrightarrow \boxed{C_e = \frac{1}{2}}$$

Equivalent Load Form Slab. =

$$\text{Factor} * w_s * (\text{Max. Load Height})$$

Where that Factor $C_a \longrightarrow$ **For Shear.**

$C_e \longrightarrow$ **For Moment.**

Shape of Load	C_a	C_e	Equivalent Load From the Slab
	1.0	1.0	$w_s \frac{L_s}{2}$
	$1-\frac{1}{2}\left(\frac{L_s}{L}\right)$	$1-\frac{1}{3}\left(\frac{L_s}{L}\right)^2$	$C_a\ w_s \frac{L_s}{2}$ $C_e\ w_s \frac{L_s}{2}$
	$\frac{1}{2}$	$\frac{2}{3}$	$C_a\ w_s \frac{L_s}{2}$ $C_e\ w_s \frac{L_s}{2}$
	$\frac{1}{2}$	$\frac{2}{3}$	$C_a\ w_s\ H$ $C_e\ w_s\ H$
	$\frac{1}{2}$	$\frac{1}{3}$	$C_a\ w_s\ L_c$ $C_e\ w_s\ L_c$
	$\frac{1}{2}$	$\frac{1}{2}$	$C_a\ w_s \frac{L_c}{2}$ $C_e\ w_s \frac{L_c}{2}$
	$\frac{1}{2}$	$\frac{2}{3}$	$C_a\ w_s\ L_c$ $C_e\ w_s\ L_c$
Any Other Shape	——	——	$\frac{\sum \text{area}}{\text{Span}} * w_s$

C_a , C_e هى **Factors** تستخدم فقط تحت عده شروط :

١- أن يكون كل الحمل بين الـ **2 Supports** بأكملهم .

٢- أن يكون شكل الحمل كما فى الأشكال السابقة فى الجدول .

و إذا لم تتوافر هذه الشروط نستخدم طريقه $\frac{\sum area}{span}$

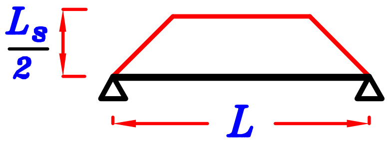
Where the equivalent load From the slab $= \frac{\sum area}{span} * w_s = \checkmark$ **kN\m`**

حيث $\sum area$ هو مجموع مساحات الأحمال الواقعه بين الـ **2 Supports**

و الـ span هى المسافه بين الـ **2 Supports** .

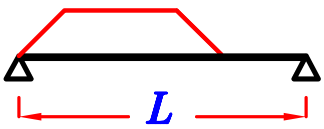
Example.

Get the Loads on the beams at the Following cases.



use C_a , C_e

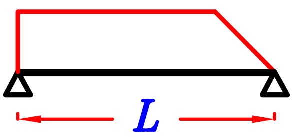
$w = O.W. + walls + C_a \, w_s \, \frac{L_s}{2}$



(The load is not Covering all the span)

$\therefore$ use $\frac{\sum area}{span}$

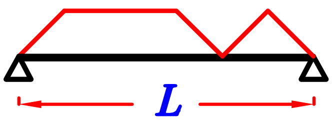
$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$



(The shape not in the table)

$\therefore$ use $\frac{\sum area}{span}$

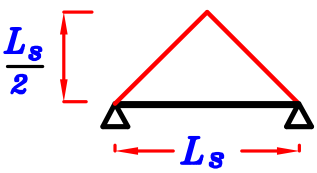
$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$



(The load is not Covering all the span)

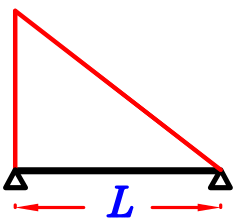
$\therefore$ use $\frac{\sum area}{span}$

$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$



use C_a , C_e

$w = O.W. + walls + C_a \, w_s \, \frac{L_s}{2}$



(The shape not in the table)

$\therefore$ use $\frac{\sum area}{span}$

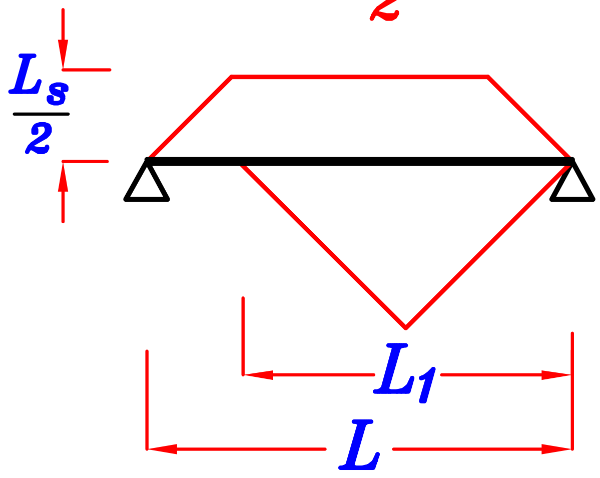
$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$

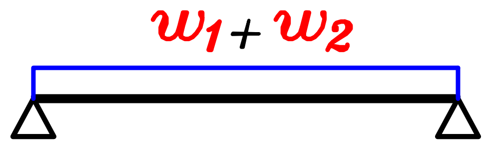
Notes.

عند وجود أكثر من حمل على الكمره نحسب كل حمل بمفرده w_1 , w_2

و هناك حالتان :

① IF $L_1 \geqslant \dfrac{L}{2}$

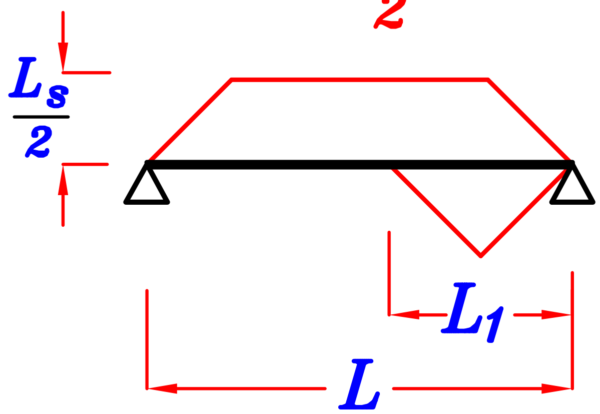


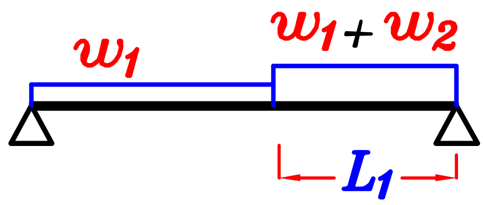


$$w_1 = C_a \, w_s \, \frac{L_s}{2}$$

$$w_2 = \frac{\sum area \triangle}{L} * w_s$$

② IF $L_1 < \dfrac{L}{2}$





$$w_1 = C_a \, w_s \, \frac{L_s}{2}$$

$$w_2 = \frac{\sum area \triangle}{L_1} * w_s$$

ملحوظه :

عند وجود كمره محموله على كمره أخرى .

يجب أولاً أن نحسب الأحمال على الكمره المحموله و نحدد لها ال ***Reaction***

عن طريق ال ***Load For Shear*** أى بأستخدام C_a

و بعد تحديد ال ***Reaction*** يُعكس على الكمره الاخرى (الحامله) .

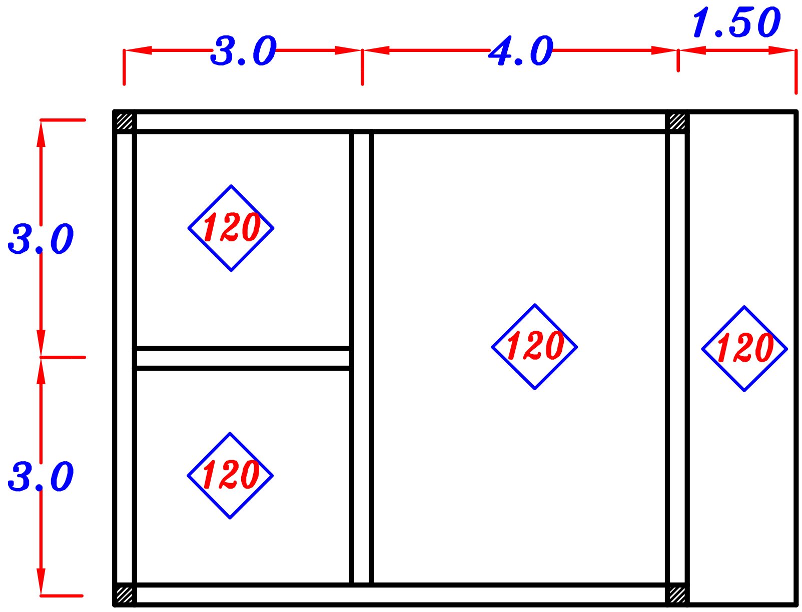
Example.

$t_s = 120\ mm$

$F.C. = 1.50\ kN\backslash m^2$

$L.L. = 2.0\ kN\backslash m^2$

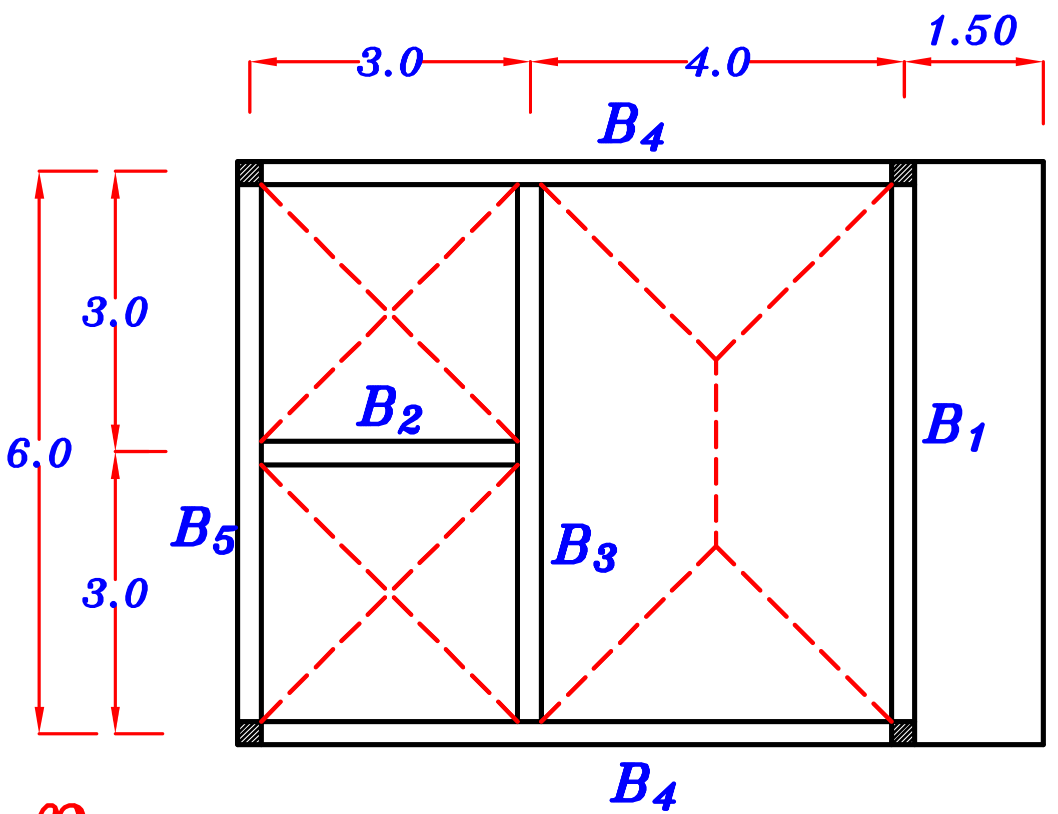
O.W. of beams $= 3.0\ kN\backslash m'$



REQ.

Draw S.F.D. & B.M.D. For all beams.

Solution.



$$w_s = g_s + p_s$$

$$= (t_s * \gamma_c + F.C.) + L.L.$$

$$= (0.12 * 25 + 1.50) + 2.0 = 6.50\ kN\backslash m^2$$

$$\boxed{w_s = 6.50\ kN\backslash m^2}$$

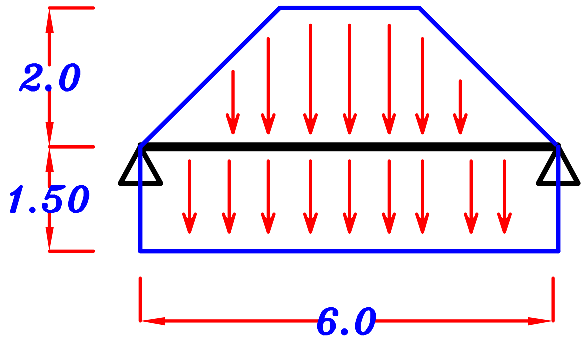
B_1

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{6}\right) = \frac{2}{3}$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{6}\right)^2 = 0.85$$

For Rectangle $C_a = C_e = 1$



Load For Shear w_a

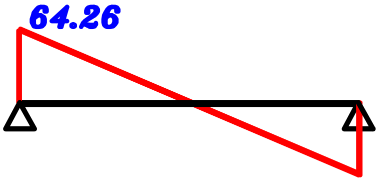
$$w_a = 0.W. + w_s L_c + C_a w_s \frac{L_s}{2} = 3.0 + (6.50)(1.5) + \frac{2}{3}(6.50)\left(\frac{4}{2}\right) = 21.42 \text{ kN\m`}$$

Load For moment w_e

$$w_e = 0.W. + w_s L_c + C_e w_s \frac{L_s}{2} = 3.0 + (6.50)(1.5) + (0.85)(6.50)\left(\frac{4}{2}\right) = 23.80 \text{ kN\m`}$$

Load For Shear

S.F.D.

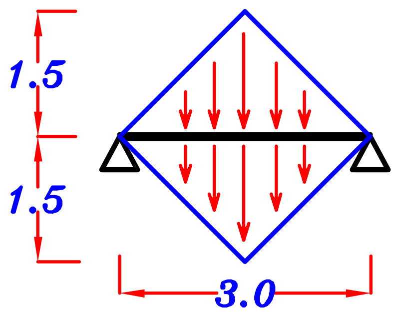


Load For Moment

B.M.D.

B_2

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$



Load For Shear w_a

$$w_a = 0.W. + 2\left(C_a w_s \frac{L_s}{2}\right) =$$

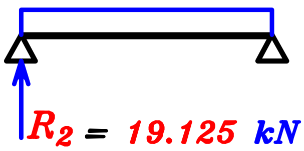
$$= 3.0 + 2\left(\frac{1}{2}(6.50)\left(\frac{3}{2}\right)\right) = 12.75 \text{ kN\m`}$$

Load For moment w_e

$$w_e = 0.W. + 2\left(C_e w_s \frac{L_s}{2}\right) =$$

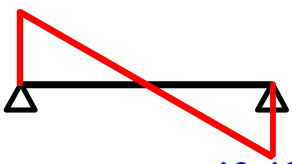
$$= 3.0 + 2\left(\frac{2}{3}(6.50)\left(\frac{3}{2}\right)\right) = 16.0 \text{ kN\m`}$$

Load For Shear



$R_2 = 19.125$ kN will be reversed on B_3 , B_5

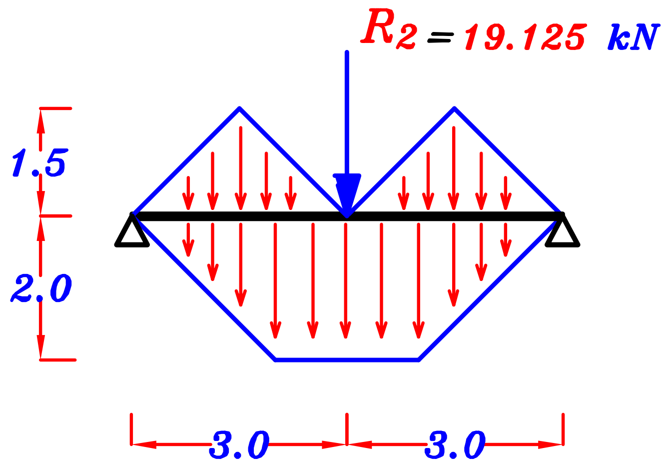
S.F.D.



Load For Moment

B.M.D.

B_3



For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{6}\right) = \frac{2}{3}$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{6}\right)^2 = 0.85$$

For Triangles

$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3)(1.5)\right)}{6} = 0.75$$

Load For Shear w_a

$$w_a = O.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{span} * w_s$$

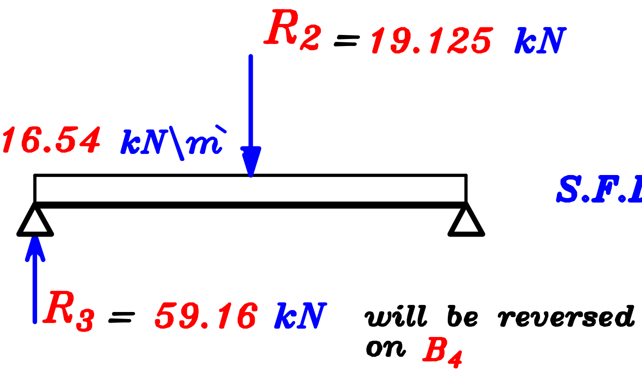
$$w_a = 3.0 + \frac{2}{3}(6.50)\left(\frac{4}{2}\right) + 0.75\,(6.50) = 16.54 \ kN\backslash m'$$

Load For moment w_e

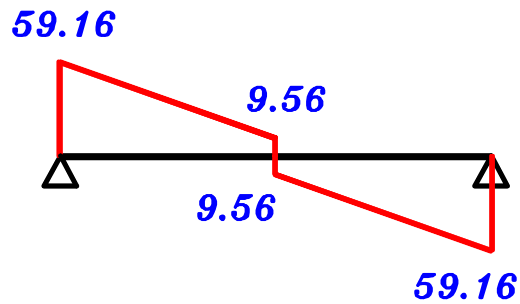
$$w_e = O.W. + C_e\, w_s \frac{L_s}{2} + \frac{\sum area}{span} * w_s$$

$$w_e = 3.0 + (0.85)(6.50)\left(\frac{4}{2}\right) + 0.75\,(6.50) = 18.925 \ kN\backslash m'$$

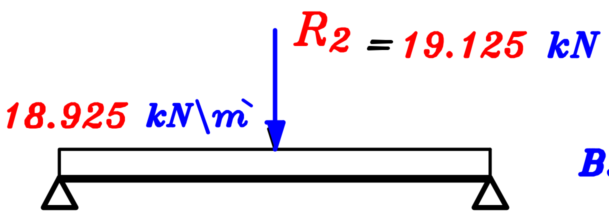
Load For Shear



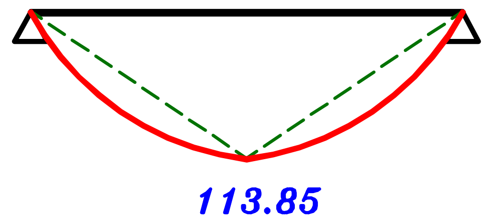
S.F.D.



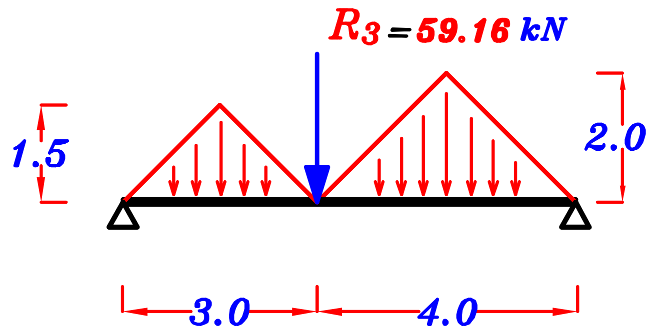
Load For Moment



B.M.D.



B_4



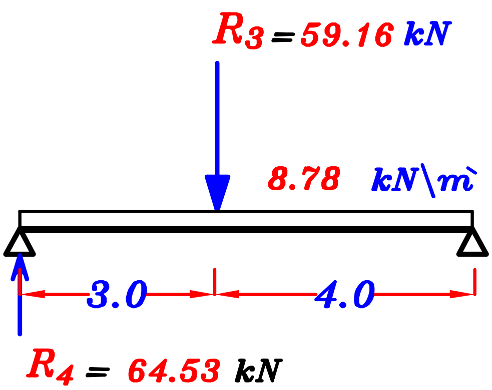
For Triangles

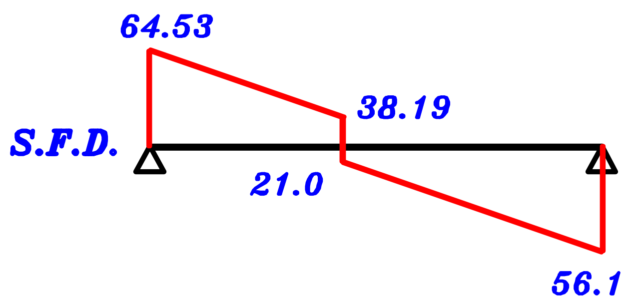
$$\frac{\sum area}{span} = \frac{\frac{1}{2}(3)(1.5)+\frac{1}{2}(4)(2)}{7.0} = 0.89$$

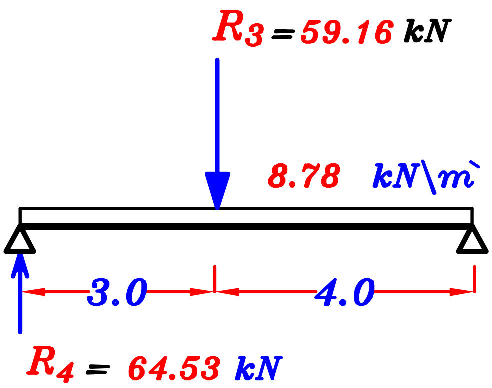
Load For Shear = Load For moment

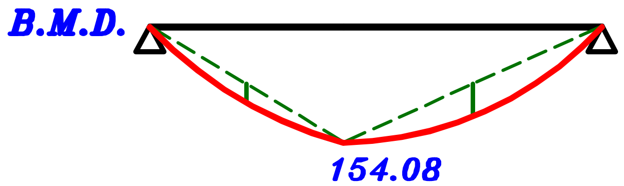
$$w_a = w_e = 0.W. + \frac{\sum area}{span} * w_s$$

$$= 3.0 + 0.89\,(6.50) = 8.78 \text{ kN\textbackslash m`}$$





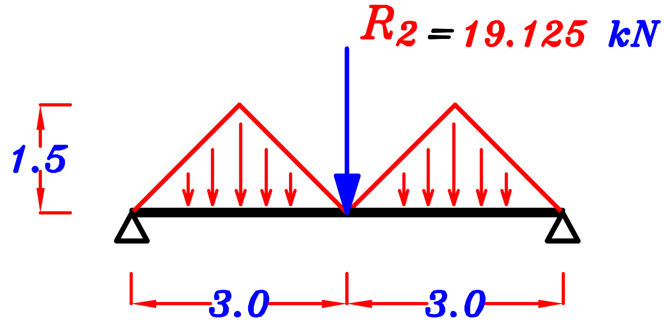




B_5

For Triangles

$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3)(1.5)\right)}{6} = 0.75$$

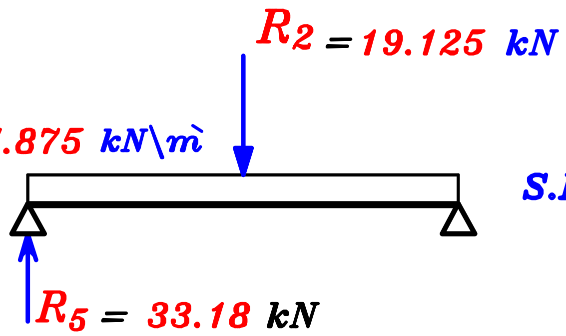


Load For Shear = Load For moment

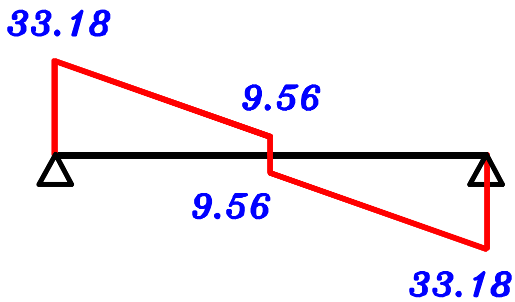
$$w_a = w_e = 0.W. + \frac{\sum area}{span} * w_s$$

$$= 3.0 + 0.75\,(6.50) = 7.875 \text{ kN}\backslash m`$$

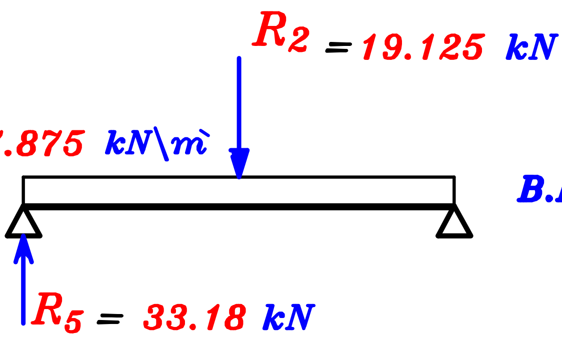
Load For Shear



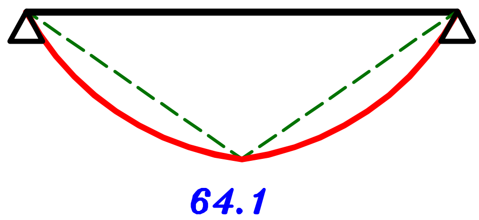
S.F.D.



Load For Moment



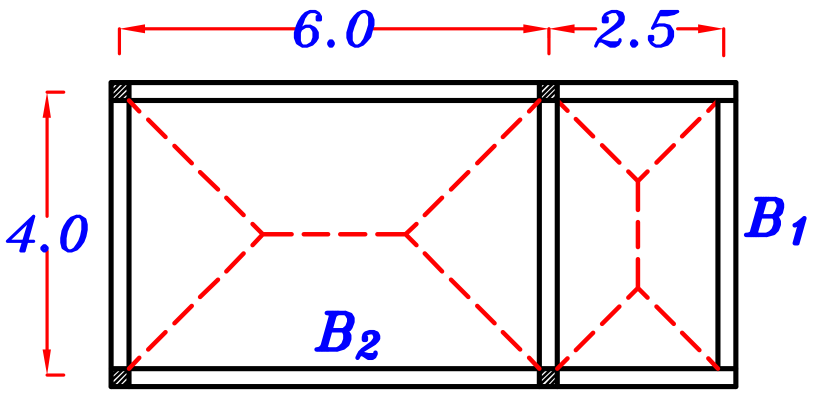
B.M.D.



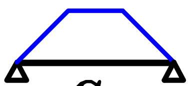
Beams with more than one span.

قاعده هامه عند حساب الاحمال على كمره بها أكثر من span
يتم حساب الـ w لكل span على حده

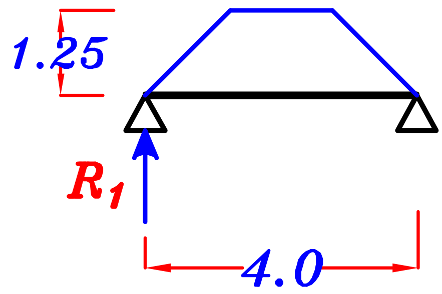
Example.



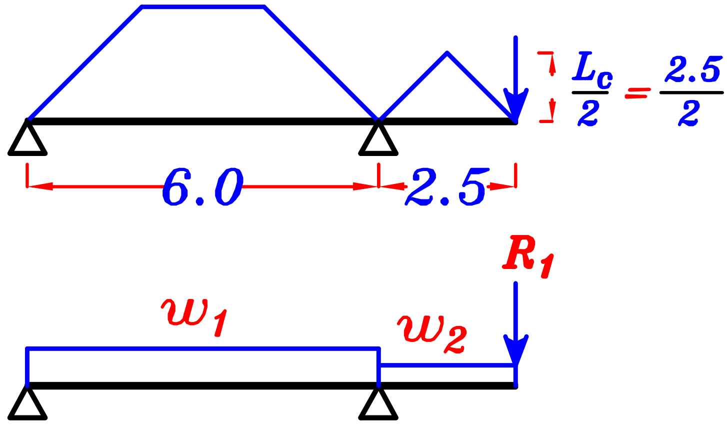
B_1

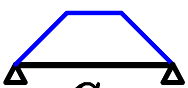


$$w = 0.W. + \frac{C_a}{C}\, w_s \, \frac{L_s}{2}$$

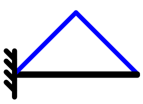


B_2



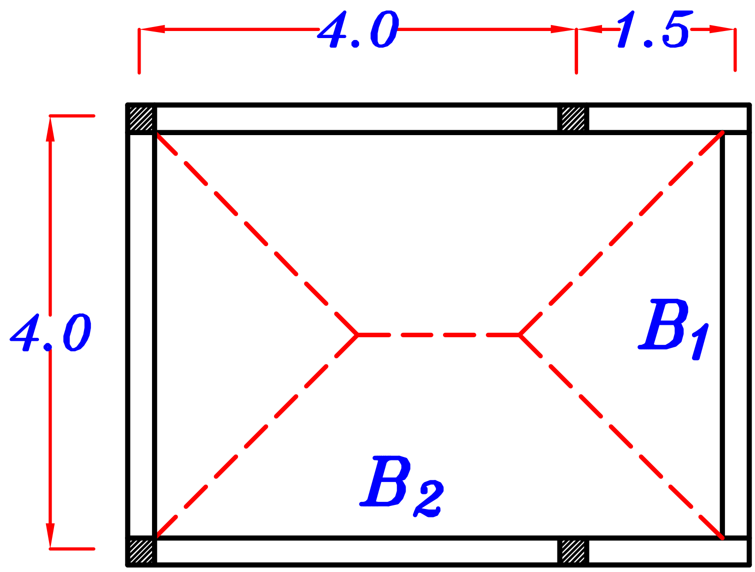


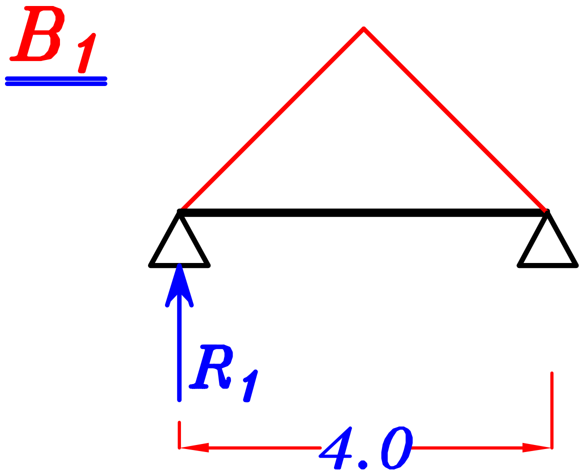
$$w_1 = 0.W. + \frac{C_a}{C_e}\, w_s \, \frac{L_s}{2}$$

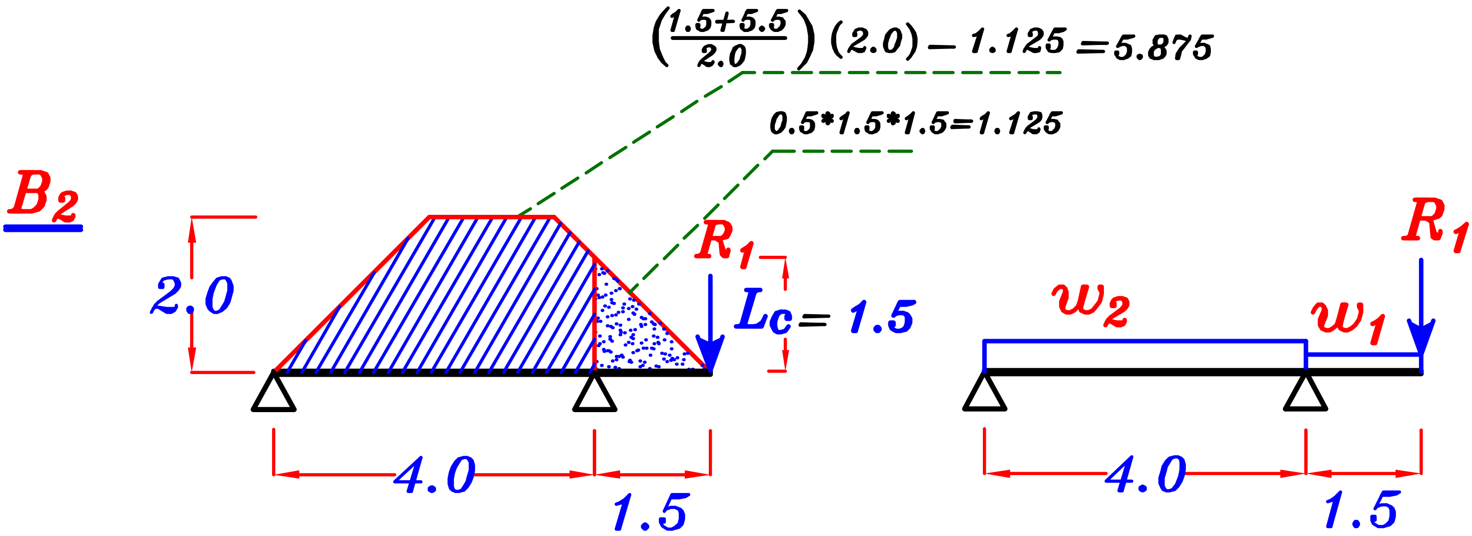


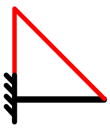
$$w_2 = 0.W. + \frac{C_a}{C_e}\, w_s \, \frac{L_c}{2}$$

Example.







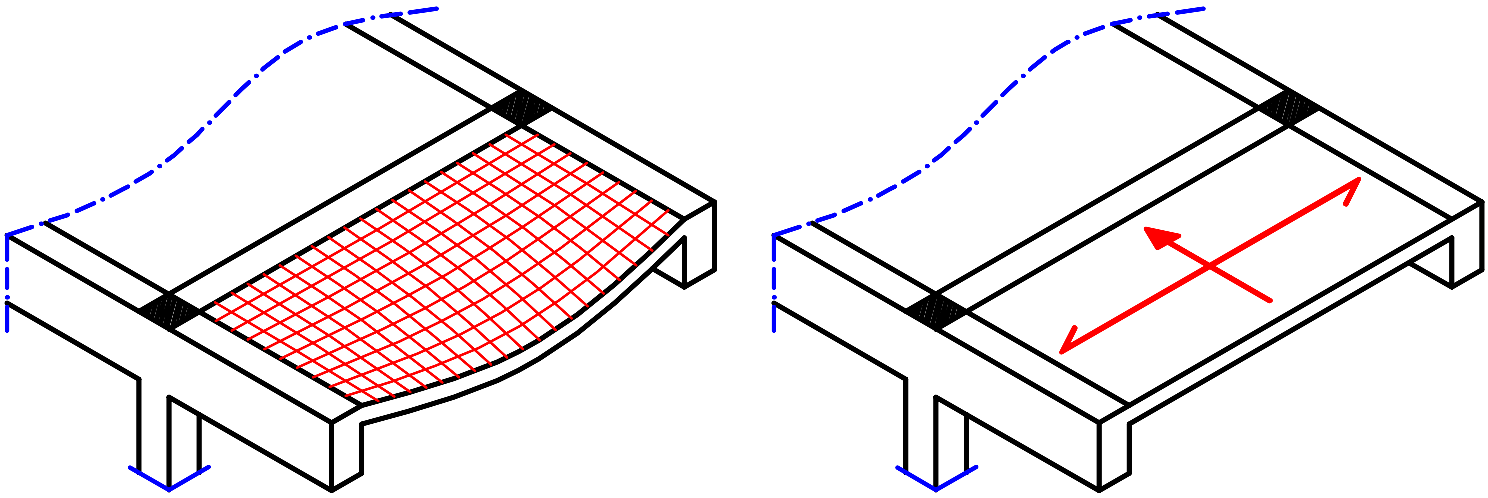


$$w_1 = 0.W. + \frac{C_a}{C_e}\ w_s\ L_c \qquad \text{where: } L_c = 1.5$$

$$w_2 = 0.W. + \frac{\sum area}{Span} * w_s = 0.W. + \frac{(5.875)}{(4.0)} * w_s$$

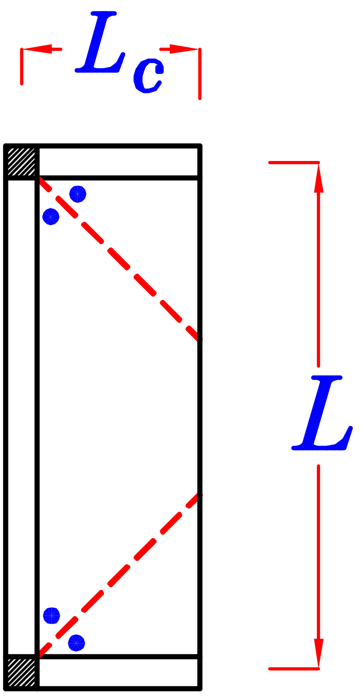
3 Sided Slabs

هى بلاطات مستطيله محموله من ثلاث جهات فقط.



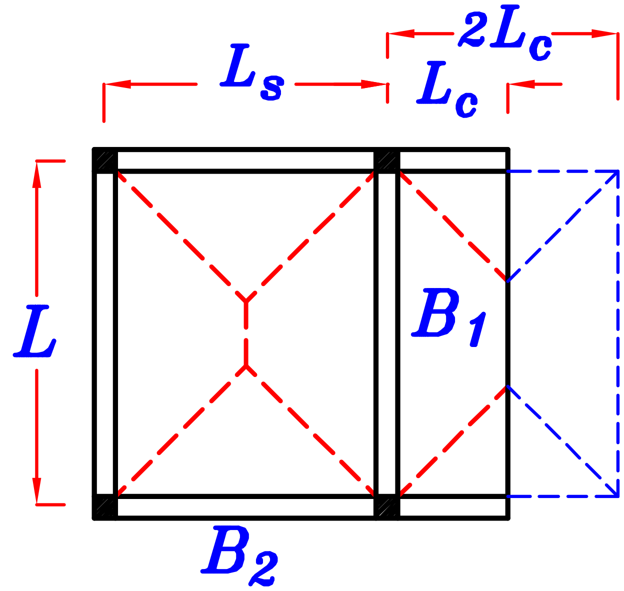
و يتوزع حمل البلاطه على الثلاث كمرات .

و لتوزيع حمل البلاطه على الكمرات يتم تنصيف الزوايا بين الكمرات .



و توجد ثلاث حالات لل 3 Sided Slabs

① IF $\boxed{L_c < \frac{L}{2}}$

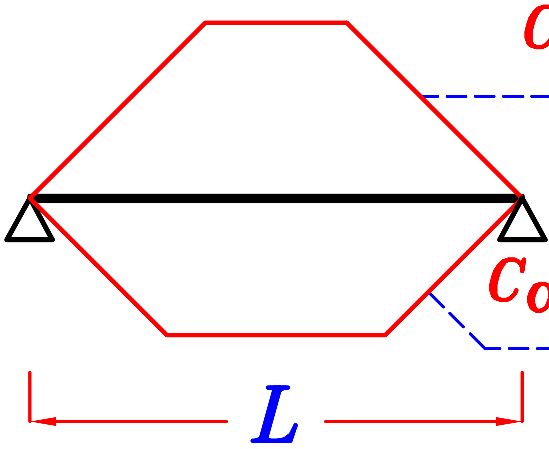


لحساب ال C_a و ال C_e لل trapezium

نحسب قيمه L و L_s للبلاطه ال two way التى كان سيأتى منها نفس ال trapezium

B_1

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right)$$

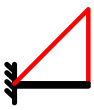


$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right)$$

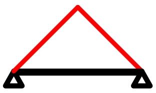
B_2

$C_a = \frac{1}{2}$

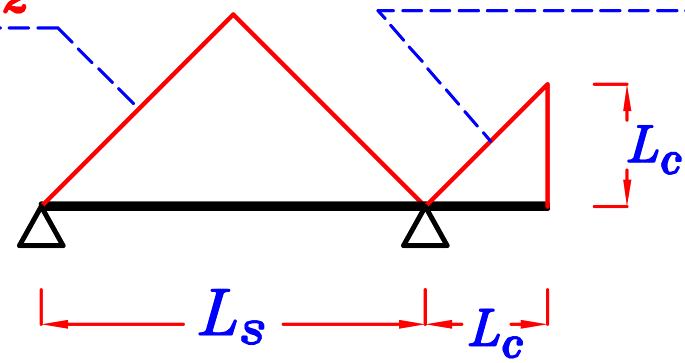
$C_a = \frac{1}{2}$, $C_a = \frac{2}{3}$

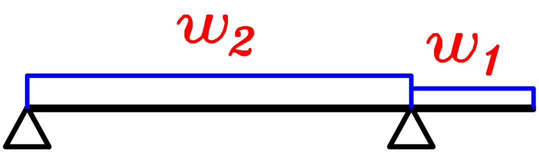


$$w_1 = O.W. + C_a \; w_s \; L_c$$

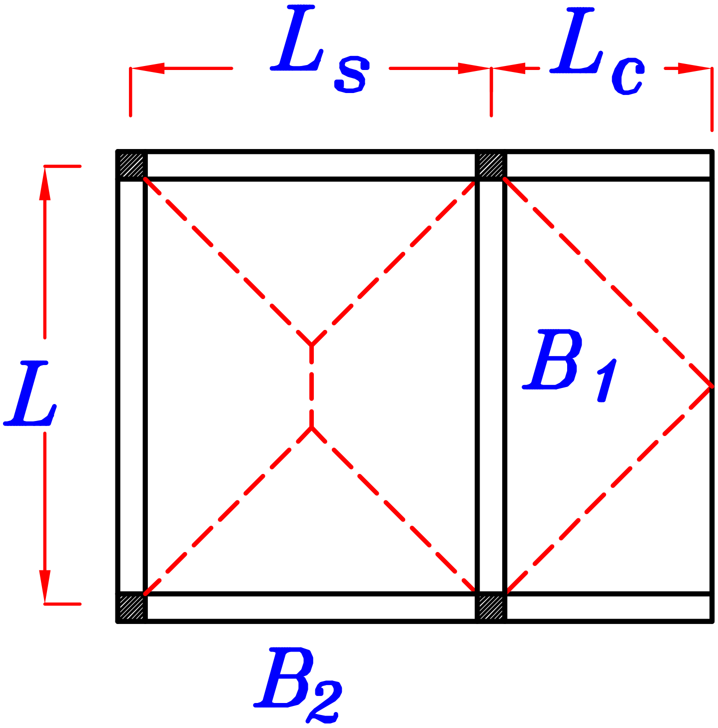


$$w_2 = O.W. + C_a \; w_s \; \frac{L_s}{2}$$

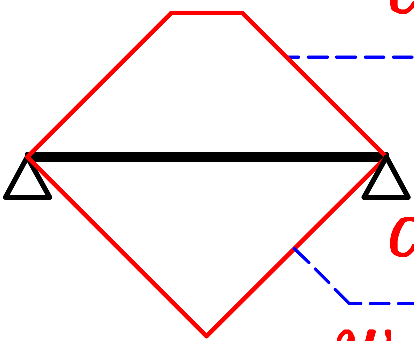




② IF $\boxed{L_c = \frac{L}{2}}$



$\underline{\underline{B_1}}$

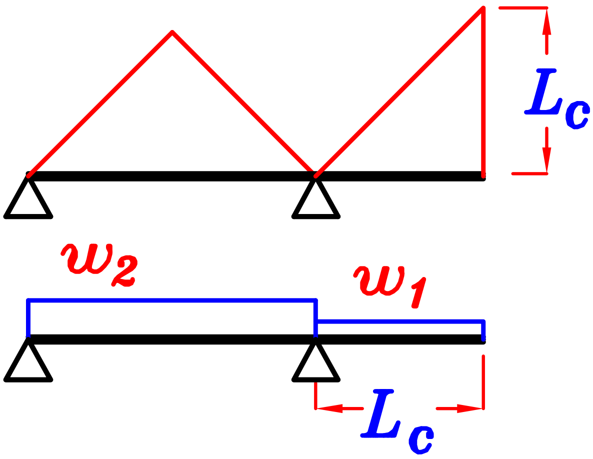


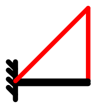
$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right)$

$C_a = \frac{1}{2}$

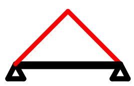
$w = C_a \; w_s \; L_c$

$\underline{\underline{B_2}}$



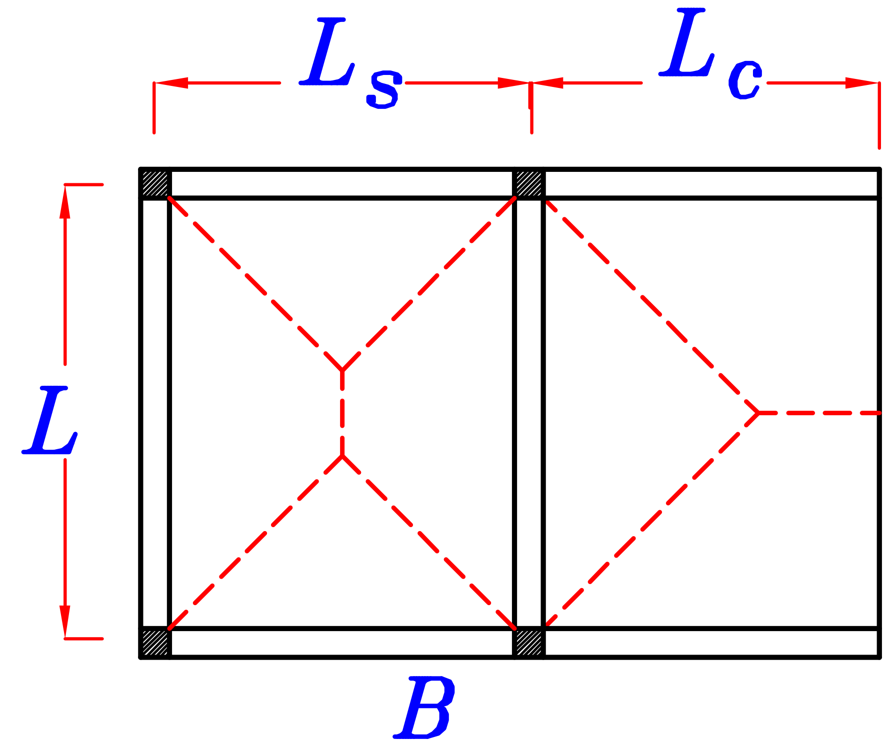


$w_1 = O.W. + C_a \; w_s \; L_c$

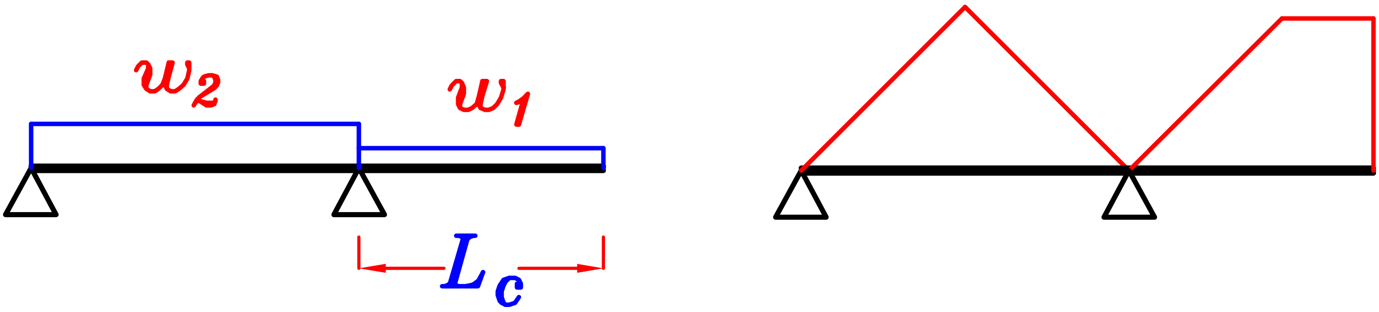


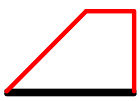
$w_2 = O.W. + C_a \; w_s \; \frac{L_s}{2}$

③ IF $\boxed{L_c > \frac{L}{2}}$

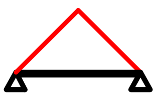


B





$$w_1 = O.W. + \frac{\sum area}{Span} * w_s$$

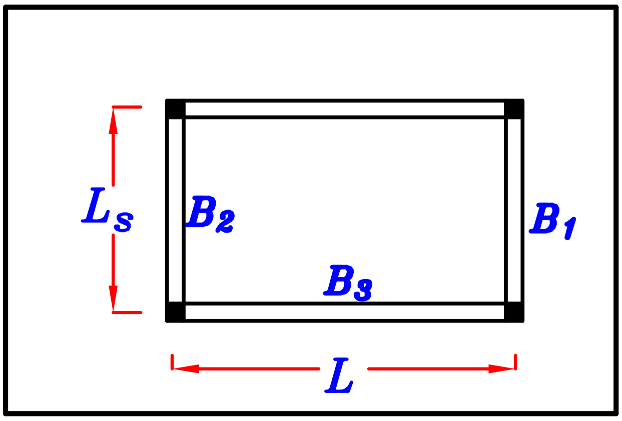


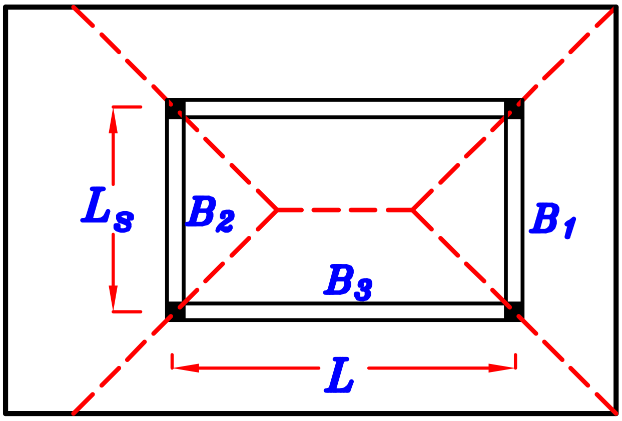
$$w_2 = O.W. + C_a \; w_s \; \frac{L_s}{2}$$

Slabs with external angels.

Example.

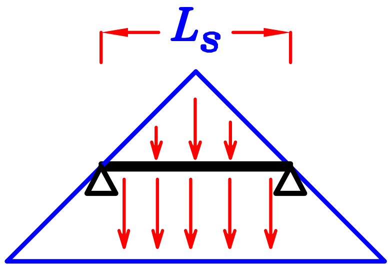
يتم تنصيف الزوايا الداخليه و الخارجيه بين الكمرات





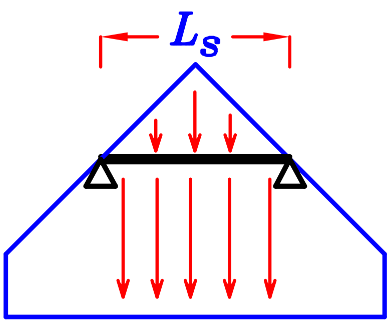
B_1

$$w_1 = 0.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span = L_s} * w_s$$



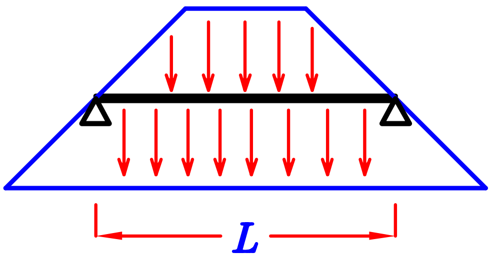
B_2

$$w_2 = 0.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span = L_s} * w_s$$

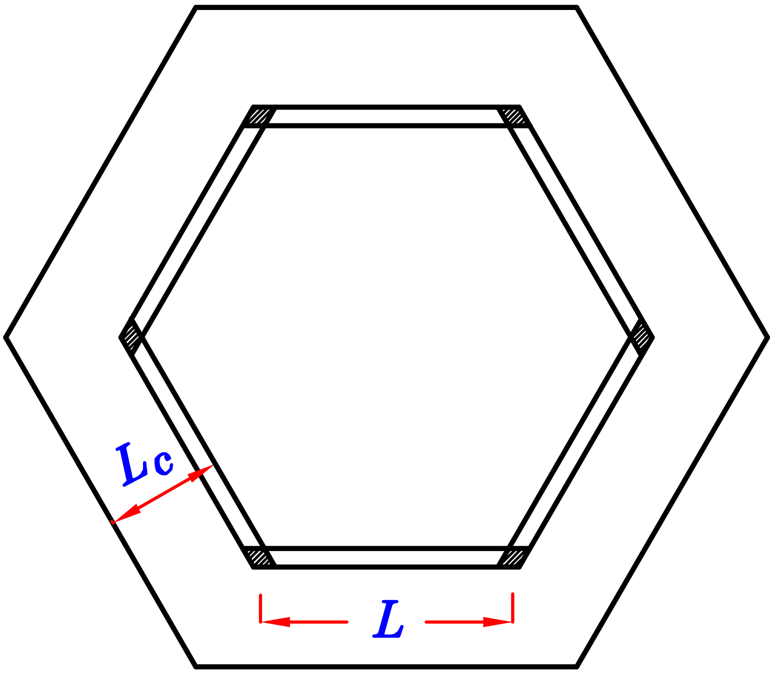


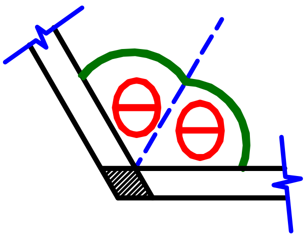
B_3

$$w_3 = 0.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span = L} * w_s$$

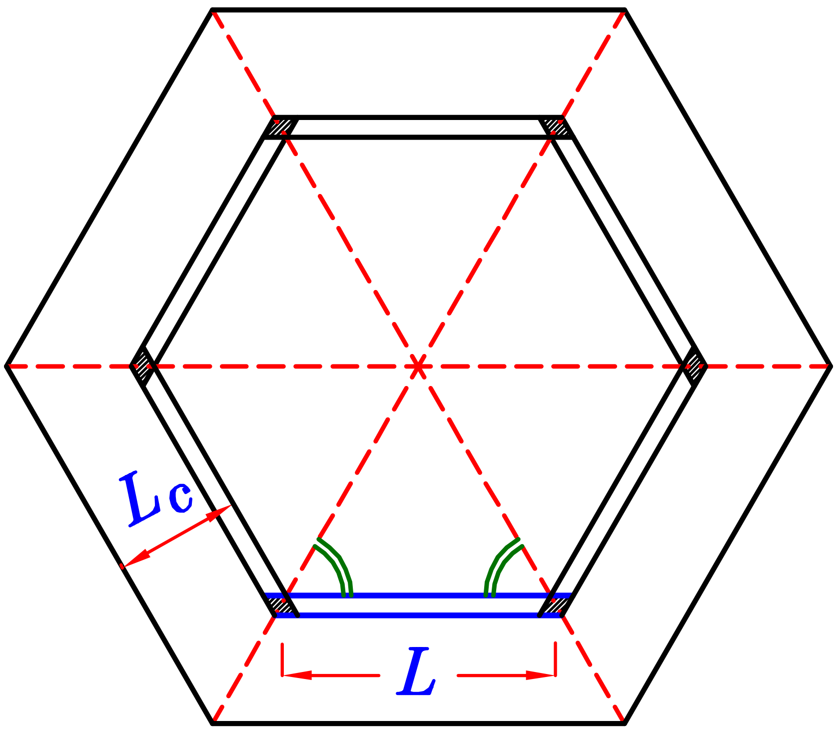


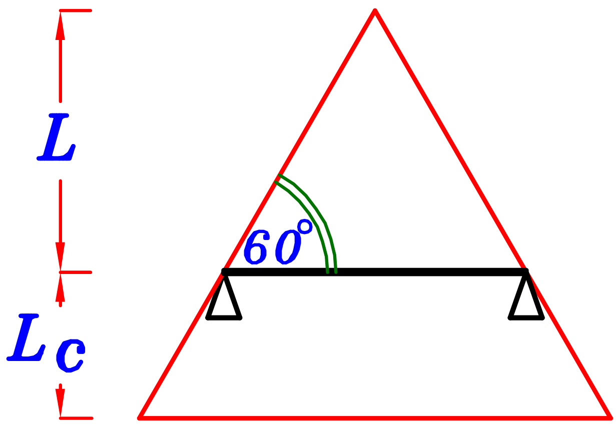
Example.

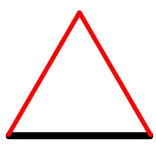




يتم تصنيف الزوايا بين الكمرات حتى لو لم تكن ٩٠°





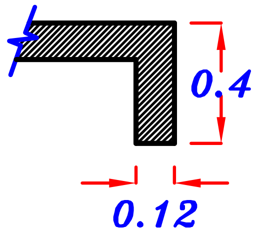


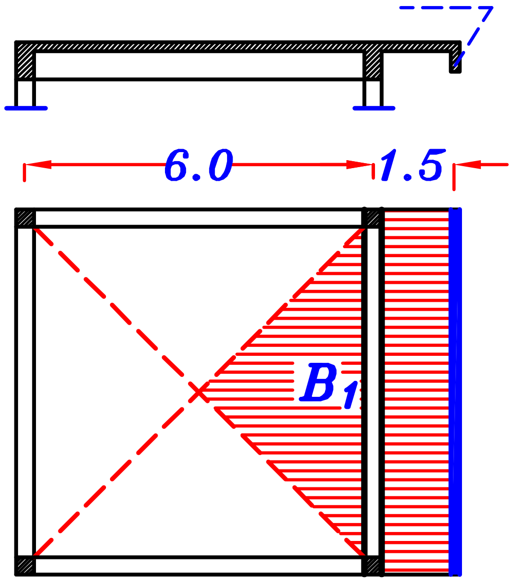
$$w = O.W. + C_a \, w_s \, L + \frac{\sum area}{Span} * w_s$$

Parapet rested on slabs. سور محمول على البلاطه

مراية

$o.w.(\text{المراية}) = (b)\,(t)\,\gamma_c = \checkmark \;(kN/m')$





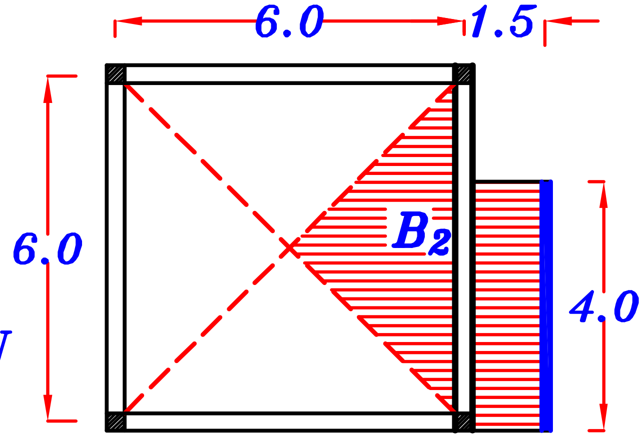
طول المرايه نفس طول الكمره

B_1

$$w = o.w.(\text{الكمره}) + o.w.(\text{المراية}) + w_s\,L_c + C_a\,w_s\,\frac{L_s}{2}$$

B_2

طول المرايه ليس نفس طول الكمره

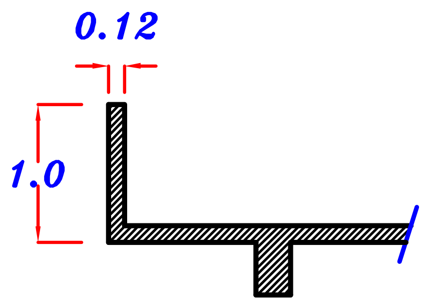


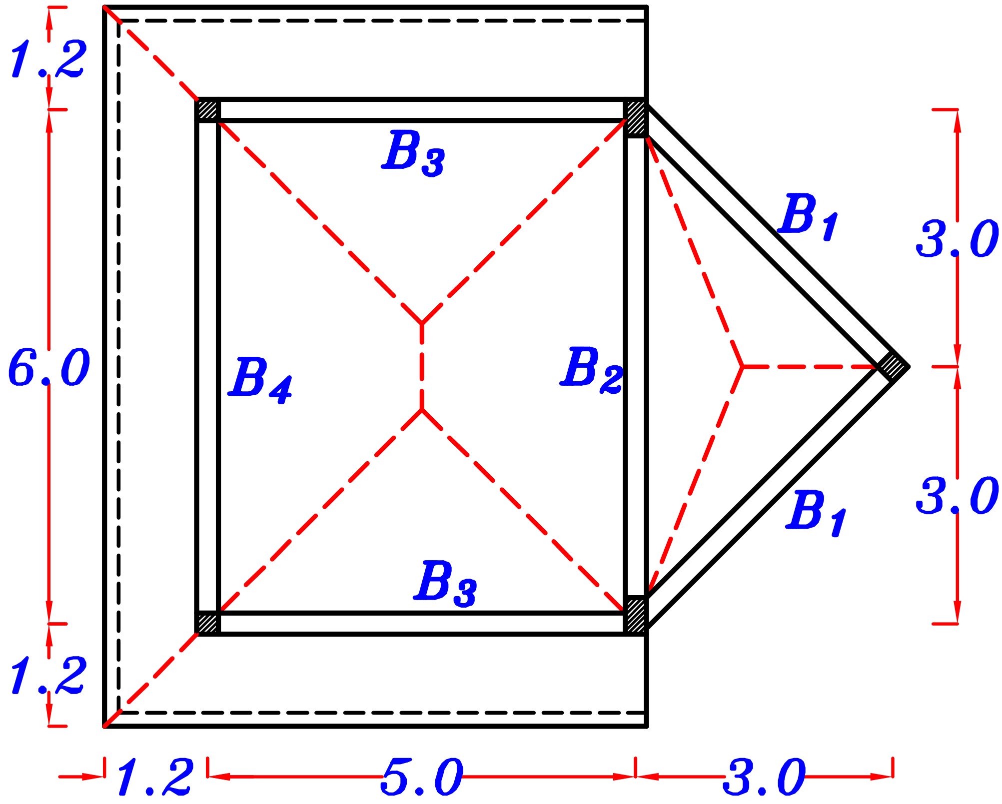
$weight\,(\text{المراية}) = (b)\,(t)\,\gamma_c * 4.0 = \checkmark\; kN$

المراية

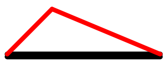
$$w = o.w. + C_a\,w_s\,\frac{L_s}{2} + \frac{\sum area}{Span = 6.0\,m} * w_s + \frac{\sum weight}{Span = 6.0}$$

Example.

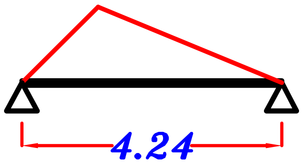




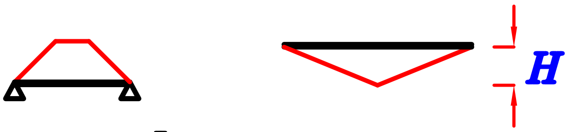
B_1



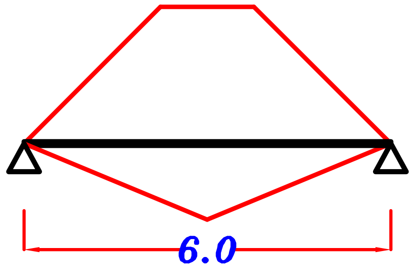
$$w_1 = O.W. + \frac{\sum area}{Span_{=4.24m}} * w_s$$



B_2



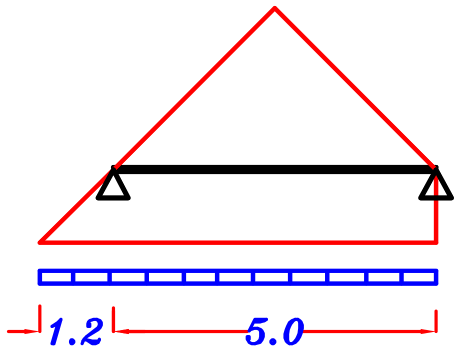
$$w_2 = O.W. + C_a\, w_s\, \frac{L_s}{2} + C_a\, w_s\, H$$



B_3

Fence

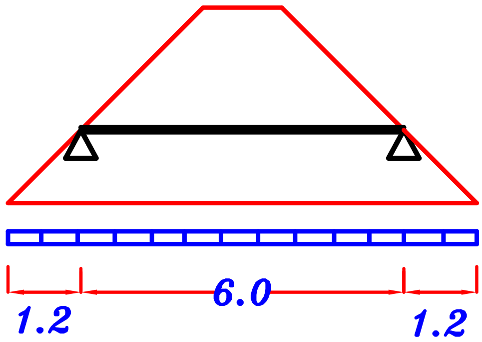
$$w_3 = O.W. + C_a\, w_s\, \frac{L_s}{2} + \frac{\sum area}{Span_{=5.0}} * w_s + \frac{\sum weight}{Span_{=5.0}}$$



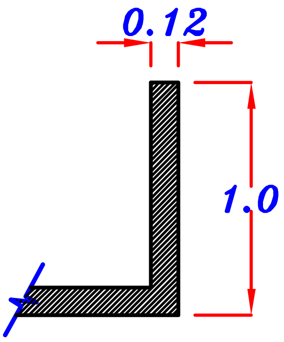
B_4

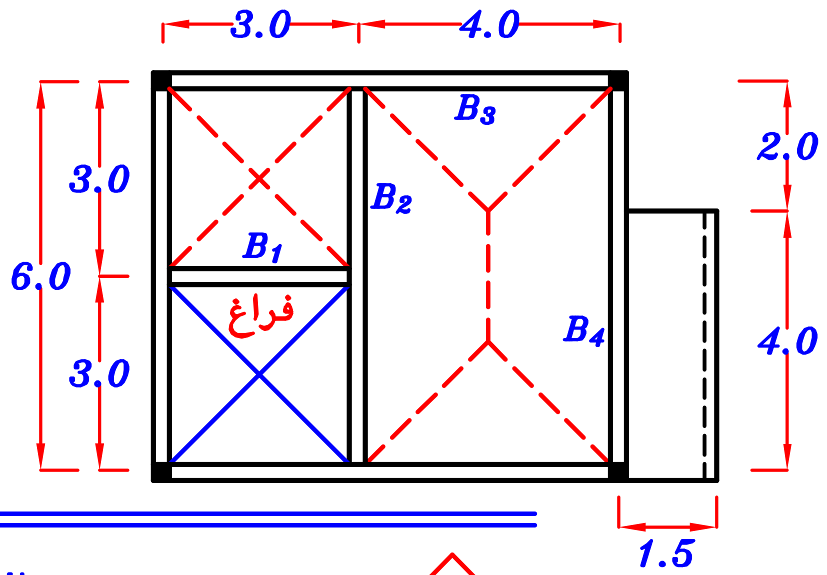
Fence

$$w_4 = O.W. + C_a\, w_s\, \frac{L_s}{2} + \frac{\sum area}{Span_{=6.0}} * w_s + \frac{\sum weight}{Span_{=6.0}}$$

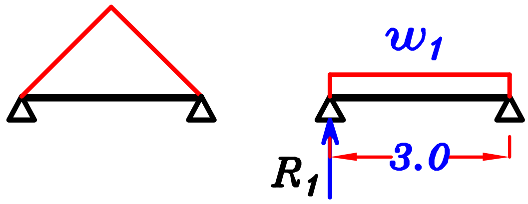


Example.



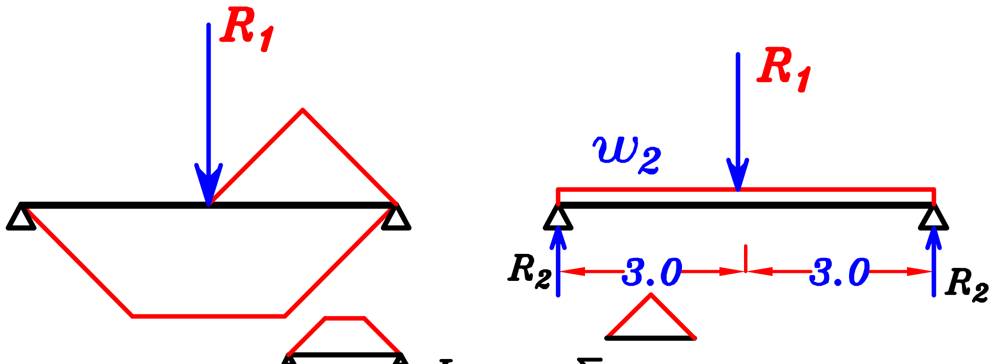


B_1



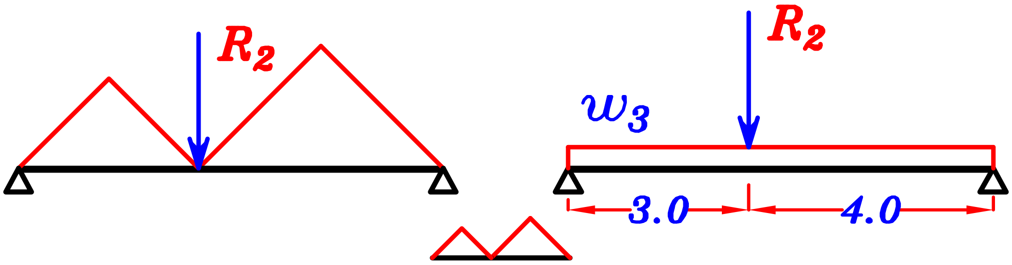
$$w_1 = O.W. + C_a \; w_s \; \frac{L_s}{2}$$

B_2



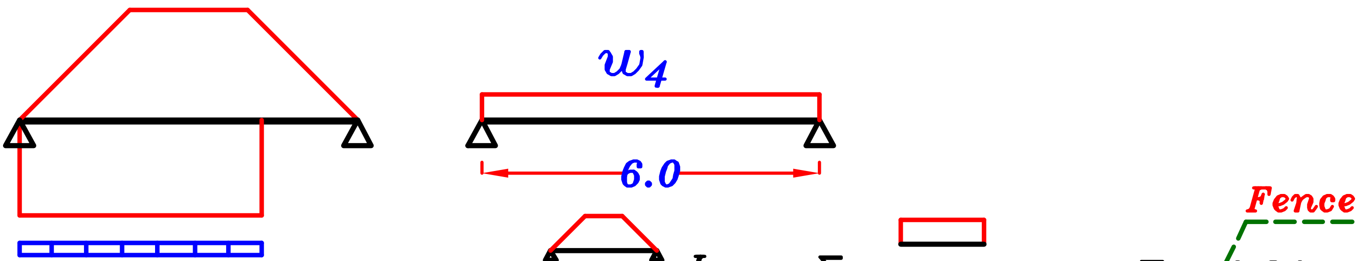
$$w_2 = O.W. + C_a \, w_s \, \frac{L_s}{2} + \frac{\sum area}{Span = 6.0\,m} * w_s$$

B_3



$$w_3 = O.W. + \frac{\sum area}{Span = 6.0\,m} * w_s$$

B_4



$$w_4 = O.W. + C_a \, w_s \, \frac{L_s}{2} + \frac{\sum area}{Span = 6.0\,m} * w_s + \frac{\sum weight}{Span = 6.0}$$

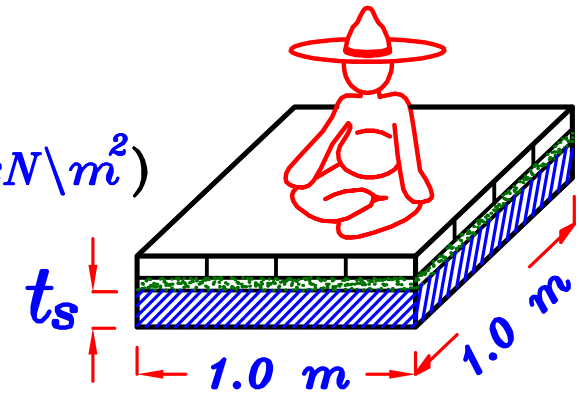
Weight of the Fence $= (0.12 * 1.0 * 4.0)\,(25.0)$

Max-Max B.M.D.

لرسم max-max B.M.D. للكمره يجب أولا أن نعمل
على حساب كلا من Dead Load و ال Live Load على حده .

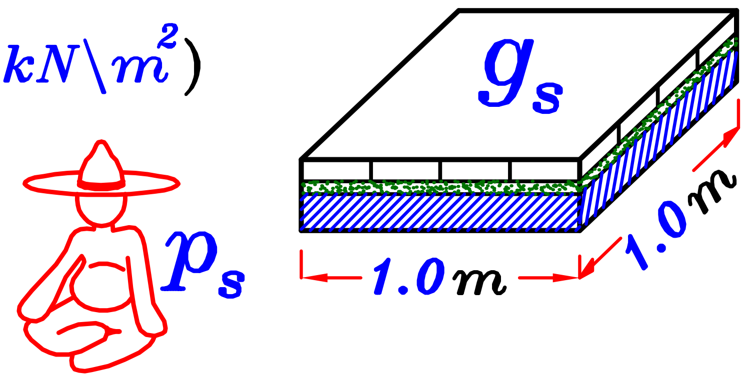
Load of the Slab.

$$\boxed{w_s = t_s * \gamma_c + F.C. + L.L.} \quad (kN\backslash m^2)$$

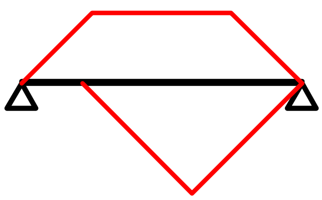


$$\boxed{g_s = t_s * \gamma_c + F.C.} \quad (kN\backslash m^2)$$

$$\boxed{p_s = L.L.} \quad (kN\backslash m^2)$$



لحساب الاحمال على الكمره فى حاله ال Total Load



$$w_a = O.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span} * w_s$$

لكن لحساب الاحمال فى حاله ال max-max
يتم حساب كلا من D.L. & L.L. على حده و جمعهم لحساب ال T.L.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + \frac{\sum area}{Span} * g_s$$

$$p_a = C_a\, p_s \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_a = g_a + p_a$$

خطوات حل مسائل Load Distribution

١- ننقل ال plan فى ورقه الاجابه (مسائل ال plans)

نستنتج ال plan و نرسمه فى ورقه الاجابه (مسائل ال X-sec.)

يفضل الرسم بمقياس رسم ١ : ١٠٠

٢- نرسم شكل Load Distribution على ال plan .

٣- نرقم الكمرات B_1 , B_2 , B_3 ..... (يتم ترقيم الكمرات المحموله أولا)

و اذا وجد كمرتان لهم نفس الطول و نفس الاحمال نرقمهم بنفس الترقيم .

٤- نحسب قيمه w_s (اذا كانت المسأله Total Load)

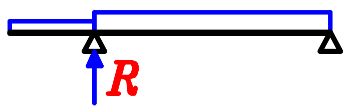
نحسب قيمه g_s , p_s (اذا كانت المسأله max-max)

نحسب o.w. الكمرات اذا لم تكن معطاه .

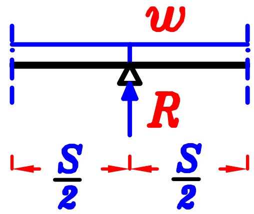
نحسب وزن الحوائط إن وجدت .

٥- نحسب قيمه Reactions للكمرات المحموله على ال Girder .

(فى مسائل ال plans نحسب ال R مثل ال structure)



(فى مسائل الX-sec. نحسب ال $R = w * S$)



٦- نضع الاحمال على ال Girder بالترتيب التالى :-

أ- نضع o.w. على ال Girder كله .

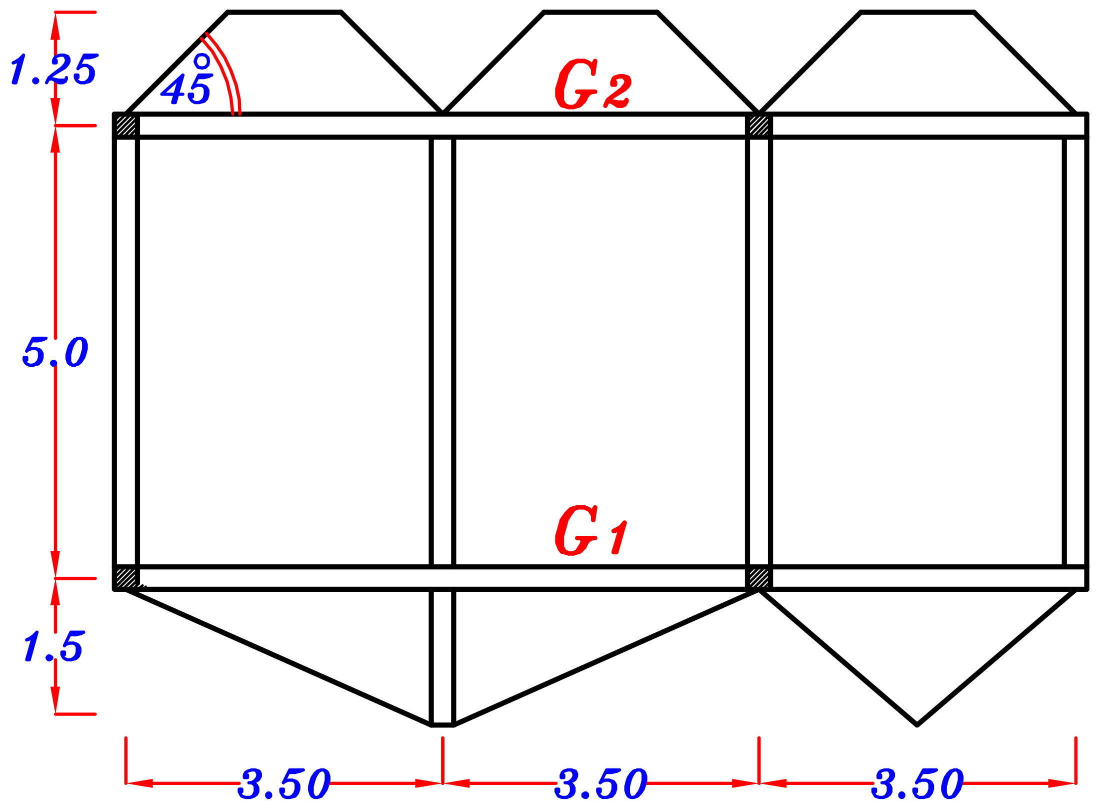
ب - نضع Reactions الكمرات الثانويه concentrated loads على ال Girder .

ج - نضع أحمال البلاطه التى تنتقل مباشره من البلاطه الى ال Girder.

و تظهر هذه الاحمال من ال plan.

٧- نرسم B.M.D. & S.F.D. لل Girder حسب المطلوب Total Load or max-max. .

Example.



Data.

$t_s = 0.14\ m$

$F.C. = 2.0 \quad kN\backslash m^2$

$L.L. = 2.0 \quad kN\backslash m^2$

b (**Beams & Girders**) = $0.25\ m$

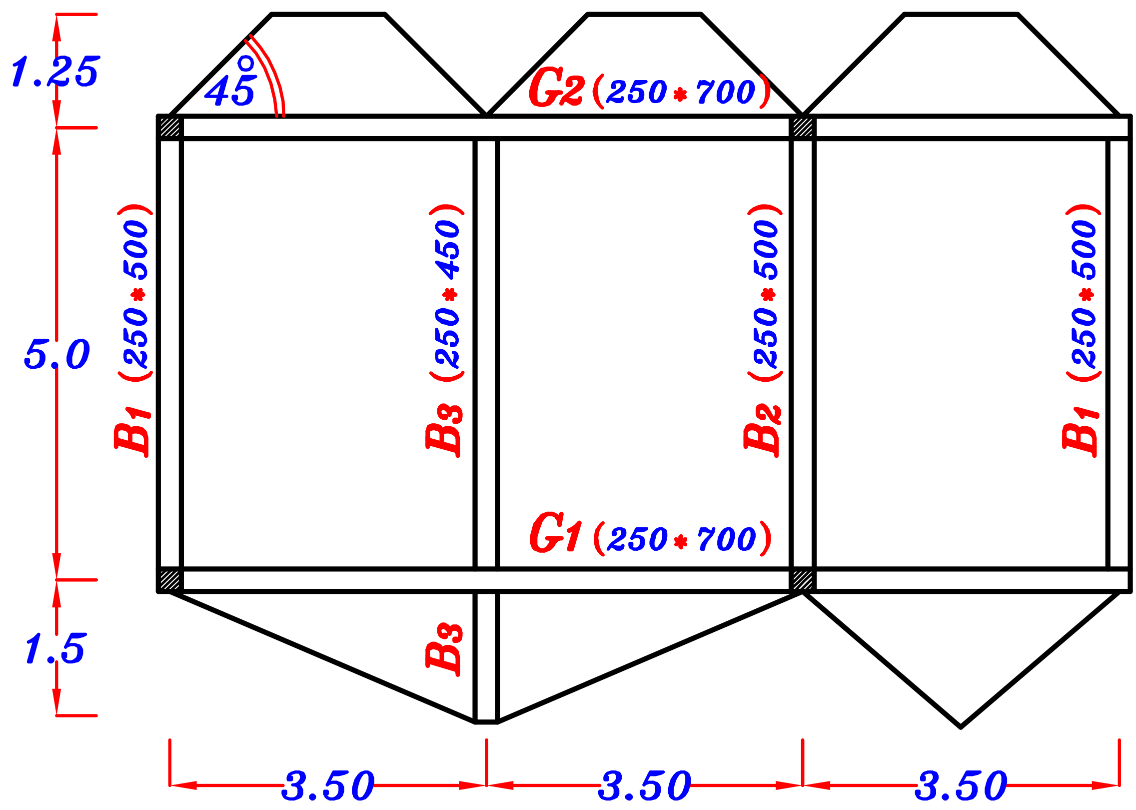
O.W. of beams & girders are reasonably assumed according to the expected depth.

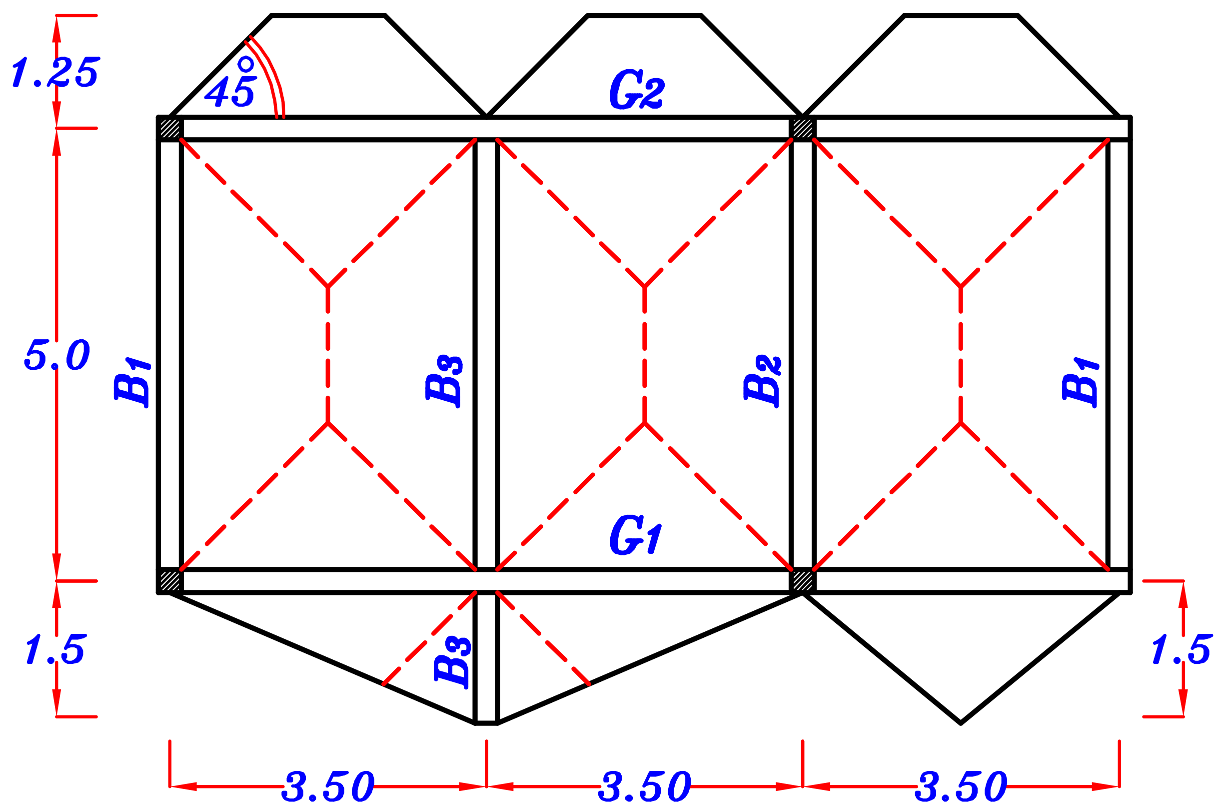
Req.

1- Draw the structural plan showing the pattern of Load Distribution.

2- Draw S.F.D. & Absolute B.M.D. For the Girders G_1 & G_2

Get b , t and o.w. For all beams.





g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 2.0 = 5.50 \ kN\backslash m^2$$

$$p_s = L.L. = 2.0 \ kN\backslash m^2$$

$\boxed{g_s = 5.50 \ kN\backslash m^2}$, $\boxed{p_s = 2.0 \ kN\backslash m^2}$

---

o.w. of Beams. $= b \ t \ \gamma_c$

B_1 , B_2 $(250*500)$ o.w. $= (0.25)(0.5)(25) = 3.12 \ kN\backslash m'$

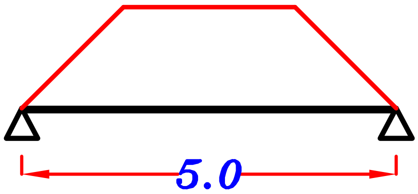
B_3 $(250*450)$ o.w. $= (0.25)(0.45)(25) = 2.81 \ kN\backslash m'$

G_1 , G_2 $(250*700)$ o.w. $= (0.25)(0.7)(25) = 4.40 \ kN\backslash m'$

B_1 (250*500)

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.50}{5}\right) = 0.65$$



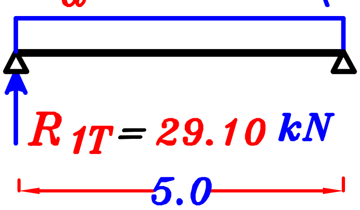
Load For shear.

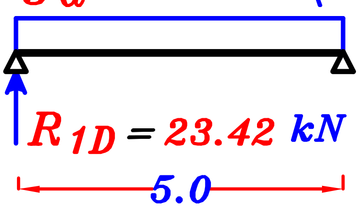
$$g_a = O.W. + \hat{C_a} \ g_s \frac{L_s}{2} = 3.12 + 0.65 \ (5.50)\left(\frac{3.50}{2}\right) = 9.37 \ kN\backslash m$$

$$p_a = C_a \ p_s \frac{L_s}{2} = 0.65 \ (2.0)\left(\frac{3.50}{2}\right) = 2.27 \ kN\backslash m$$

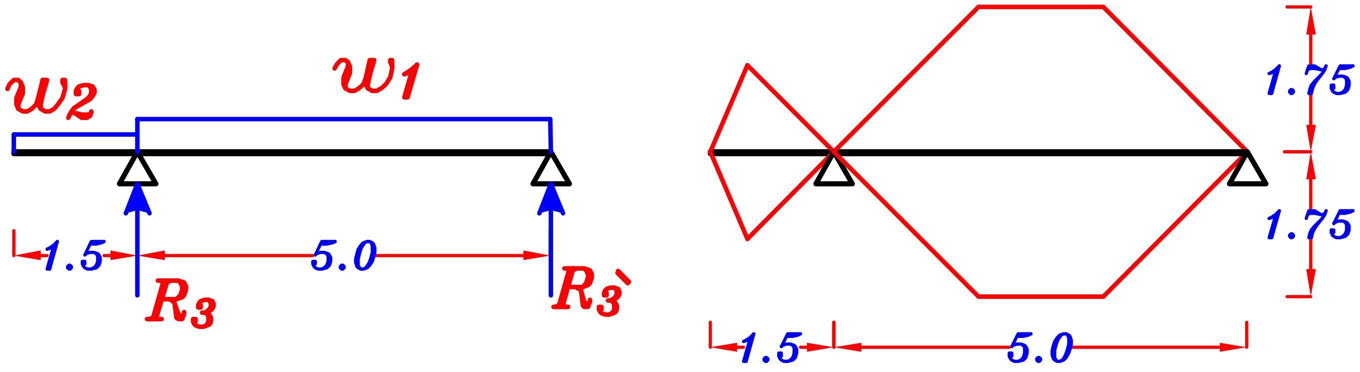
$$w_a = g_a + p_a = 9.37 + 2.27 = 11.64 \ kN\backslash m'$$

$$\boxed{\begin{array}{l} R_{1D} = 23.42 \ kN \\ R_{1T} = 29.10 \ kN \end{array}}$$





B_3 (250*450)



w_1

For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.50}{5}\right) = 0.65$

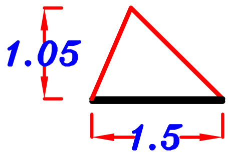
Load For shear.

$$g_1 = O.W. + 2\,C_a\,g_s\,\frac{L_s}{2} = 2.81 + 2\,(0.65)(5.50)\left(\frac{3.50}{2}\right) = 15.32 \text{ kN\m}$$

$$p_1 = 2\,C_a\,p_s\,\frac{L_s}{2} = 2\,(0.65)(2.0)\left(\frac{3.50}{2}\right) = 4.55 \text{ kN\m}$$

$$w_1 = g_1 + p_1 = 15.32 + 4.55 = 19.87 \text{ kN\m`}$$

w_2



$area = 0.787\ m^2$

$$g_2 = O.W. + \frac{\Sigma\, area}{Span} * g_s = 2.81 + \frac{2\,(0.787)(5.50)}{1.50} = 8.58 \text{ kN\m}$$

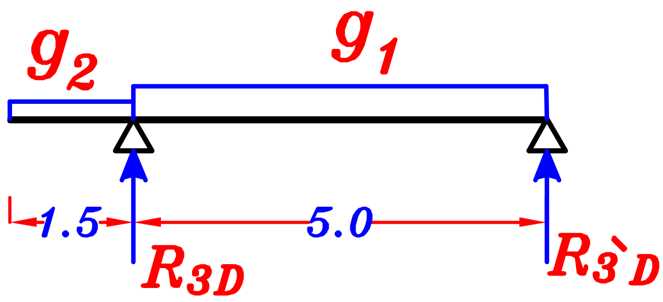
$$p_2 = \frac{\Sigma\, area}{Span} * p_s = \frac{2\,(0.787)(2.0)}{1.50} = 2.10 \text{ kN\m}$$

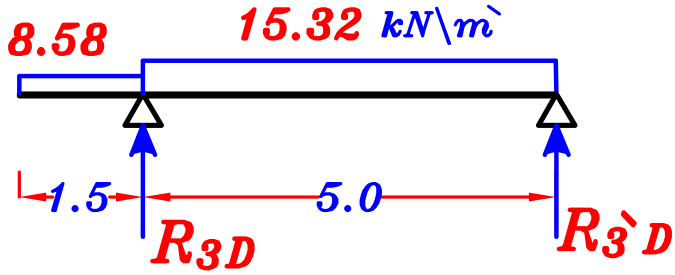
$$w_2 = g_2 + p_2 = 8.58 + 2.10 = 10.68 \text{ kN\m`}$$

Dead Load.

$R_{3D} = 53.1\ kN$

$R'_{3D} = 36.37\ kN$

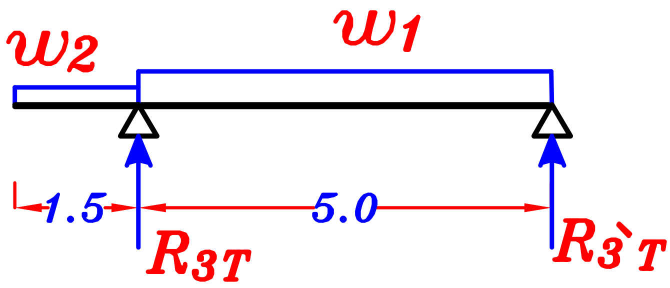


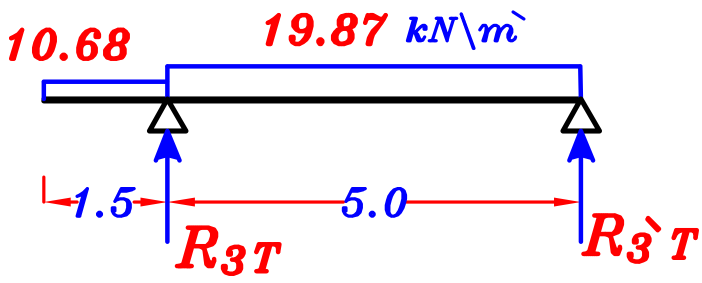


Total Load.

$R_{3T} = 68.1\ kN$

$R'_{3T} = 47.27\ kN$

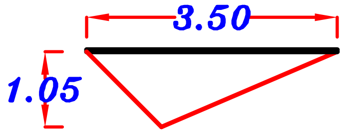




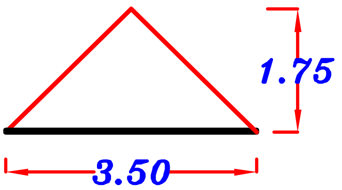
$$\left.\begin{aligned} R_{3D} &= 53.1\ kN \\ R_{3T} &= 68.1\ kN \end{aligned}\right\}\ \text{Reversed on girder } G_1$$

$$\left.\begin{aligned} R'_{3D} &= 36.37\ kN \\ R'_{3T} &= 47.27\ kN \end{aligned}\right\}\ \text{Reversed on girder } G_2$$

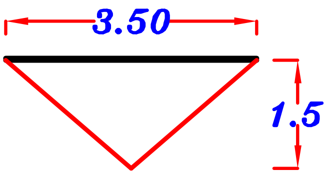
G_1 (250 * 700)



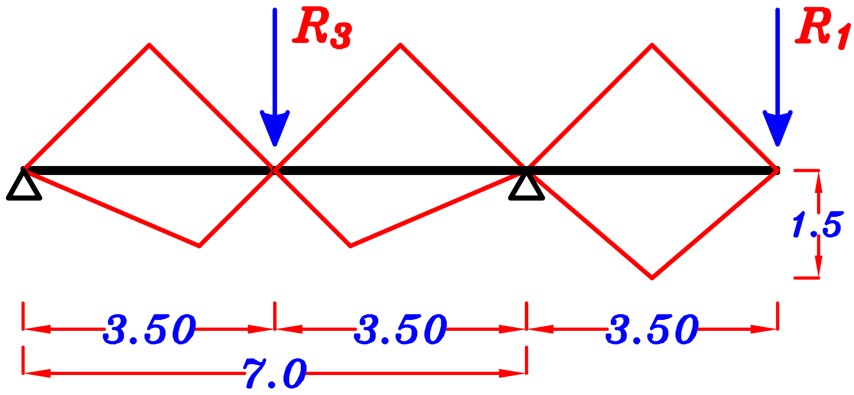
area = 1.837 m^2

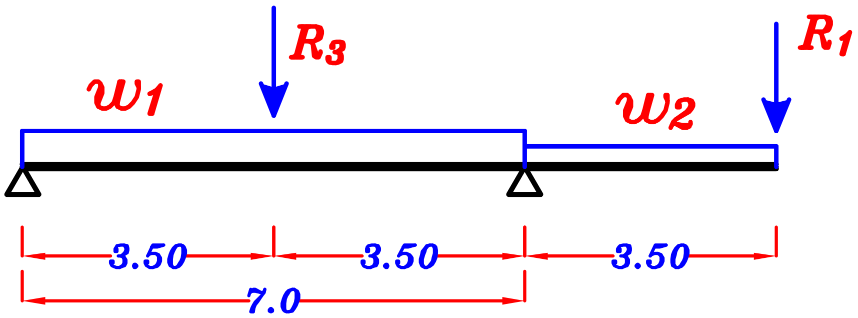


area = 3.062 m^2

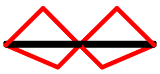


area = 2.625 m^2





w_1



$$g_1 = O.W. + \frac{\sum area}{Span} * g_s$$

$$= 4.40 + \frac{2\,(1.837) + 2\,(3.062)}{7.0}\,(5.50) = 12.10 \ kN\backslash m$$

$$p_1 = \frac{\sum area}{Span} * p_s = \frac{2\,(1.837) + 2\,(3.062)}{7.0}\,(2.0) = 2.80 \ kN\backslash m$$

$$w_1 = g_1 + p_1 = 12.10 + 2.80 = 14.90 \ kN\backslash m`$$

w_2

$$g_2 = O.W. + \frac{\sum area}{Span} * g_s + C_e \ g_s \frac{L_c}{2}$$

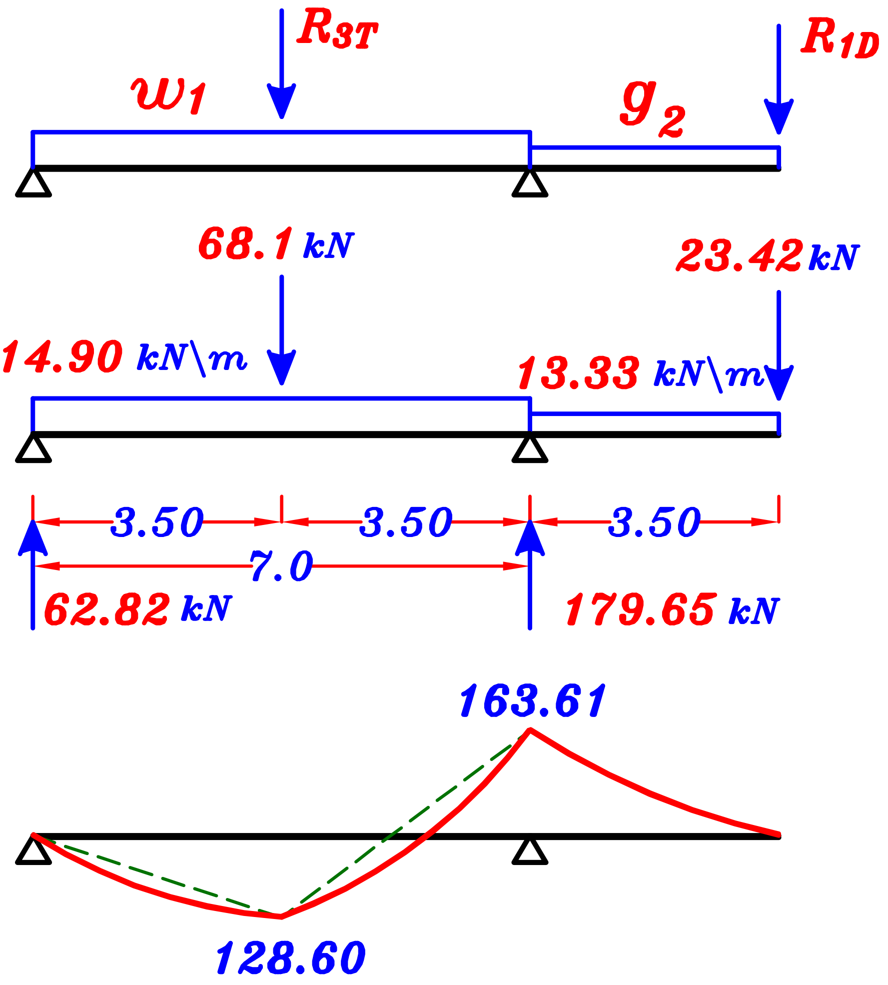
$$= 4.40 + \frac{(2.625)}{3.50}\,(5.50) + \frac{1}{2}\,(5.50)\left(\frac{3.50}{2}\right) = 13.33 \ kN\backslash m$$

$$p_2 = \frac{\sum area}{Span} * p_s + C_e \, p_s \frac{L_c}{2} = \frac{(2.625)}{3.50}\,(2.0) + \frac{1}{2}\,(2.0)\left(\frac{3.50}{2}\right) = 3.25 \ kN\backslash m$$

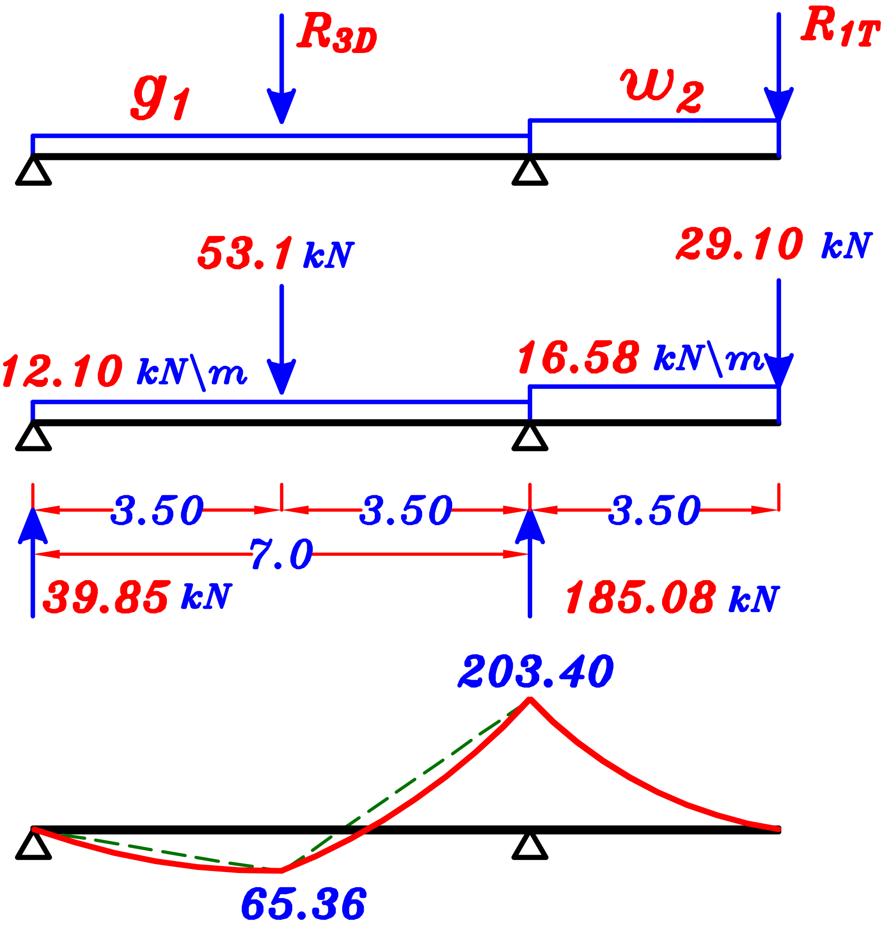
$$w_2 = g_2 + p_2 = 13.33 + 3.25 = 16.58 \ kN\backslash m`$$

max–max B.M.D. For the girder (G_1)

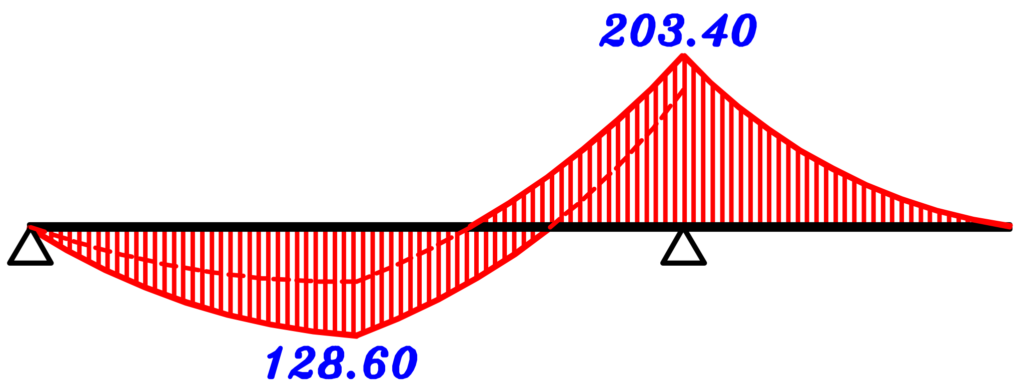
1- max. +ve B.M.D.



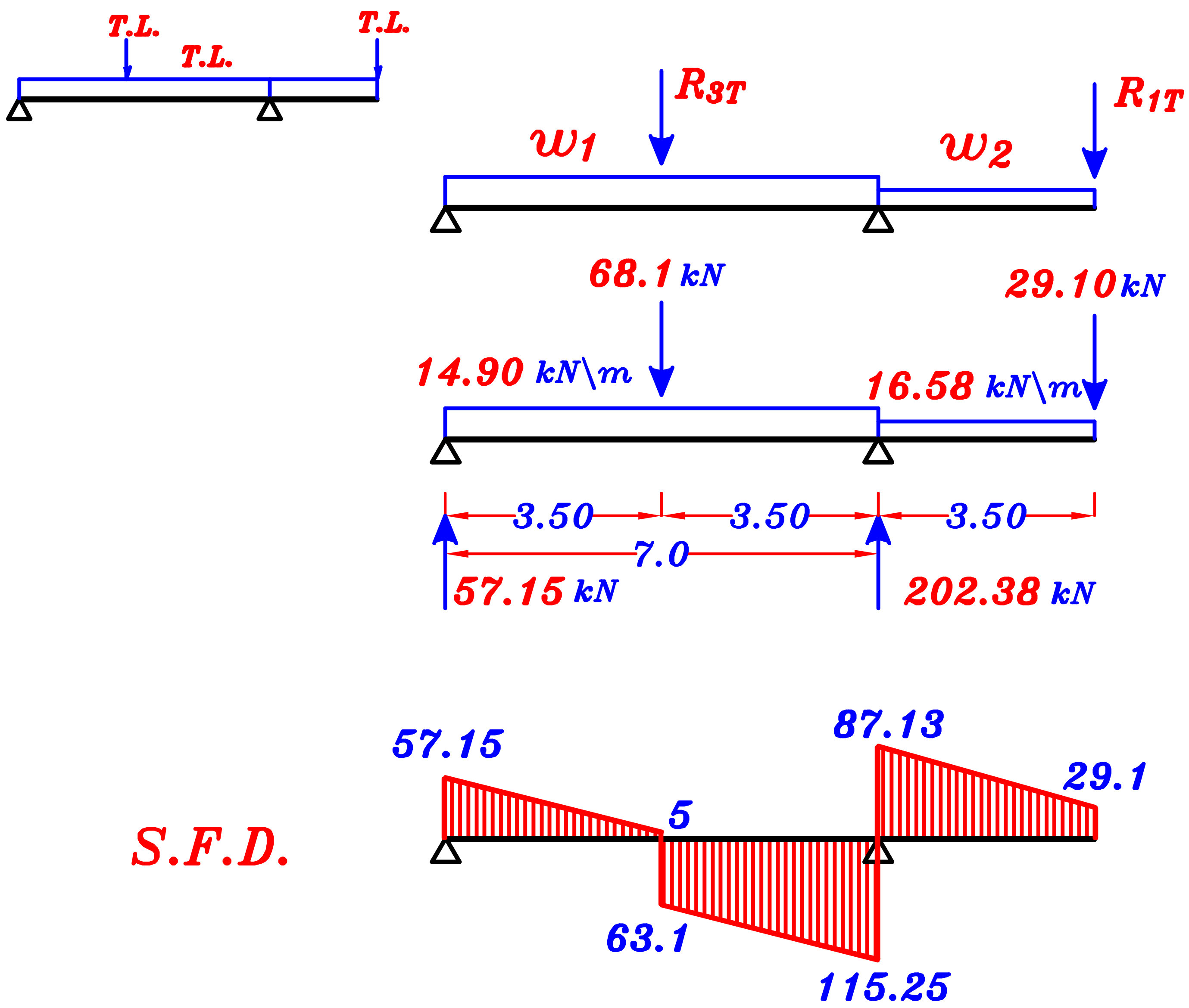
2- max. –ve B.M.D.



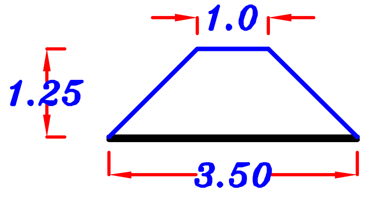
max−max B.M.D. For the girder (G_1)



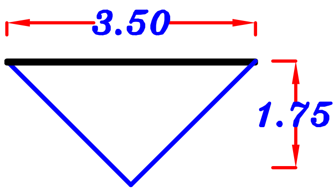
S.F.D. For the girder (G_1)



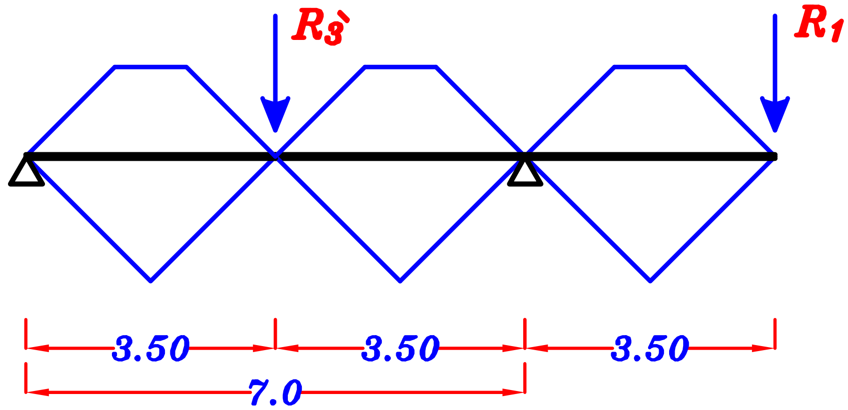
G_2 (250*700)

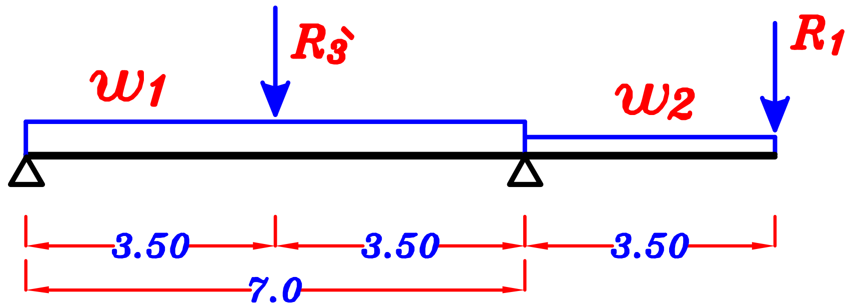


area = 2.812 m^2

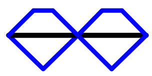


area = 3.062 m^2





w_1



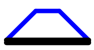
$$g_1 = O.W. + \frac{\sum area}{Span} * g_s$$

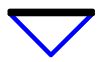
$$= 4.40 + \frac{2\,(2.812) + 2\,(3.062)}{7.0}\,(5.50) = 13.63 \; kN\backslash m$$

$$p_1 = \frac{\sum area}{Span} * p_s = \frac{2\,(2.812) + 2\,(3.062)}{7.0}\,(2.0) = 3.35 \; kN\backslash m$$

$$w_1 = g_1 + p_1 = 13.63 + 3.35 = 16.98 \; kN\backslash m$$

w_2





$$g_2 = O.W. + \frac{\sum area}{Span} * g_s + C_e \; g_s \; \frac{L_c}{2}$$

$$g_2 = 4.40 + \frac{(2.812)}{3.50}\,(5.50) + \frac{1}{2}\,(5.50)\left(\frac{3.50}{2}\right) = 13.63 \; kN\backslash m$$

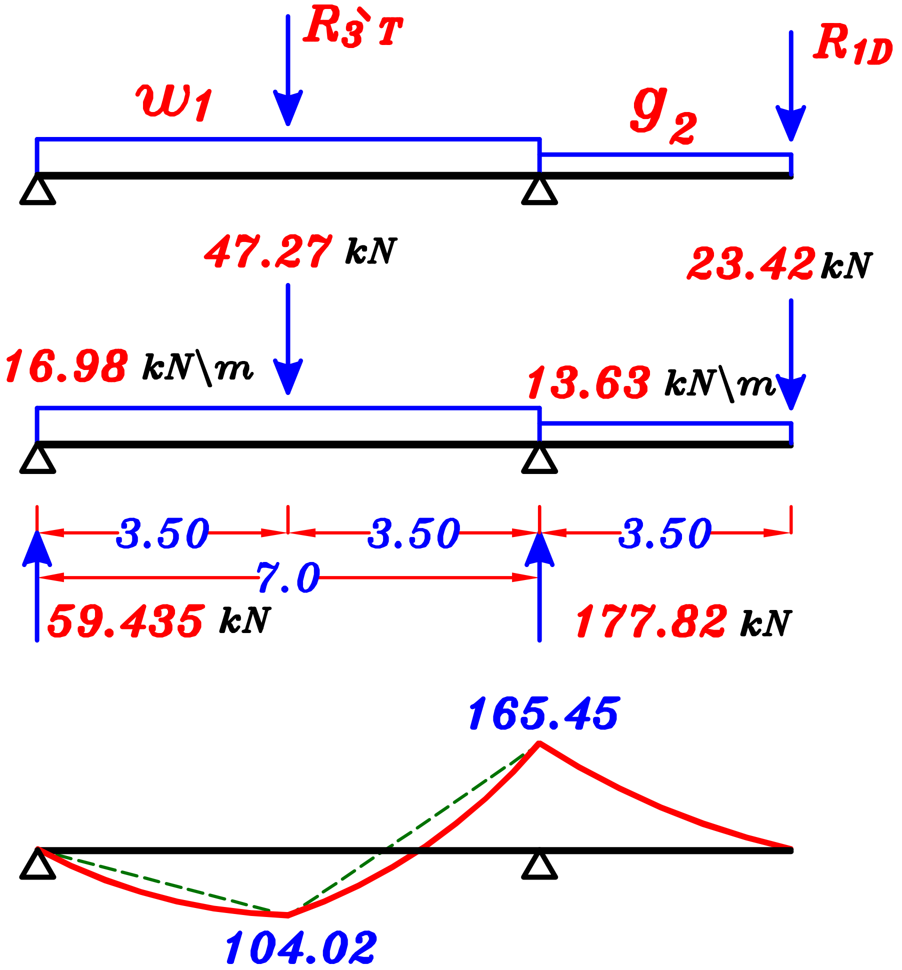
$$p_2 = \frac{\sum area}{Span} * p_s + C_e \; p_s \; \frac{L_c}{2}$$

$$= \frac{(2.812)}{3.50}\,(2.0) + \frac{1}{2}\,(2.0)\left(\frac{3.50}{2}\right) = 3.35 \; kN\backslash m$$

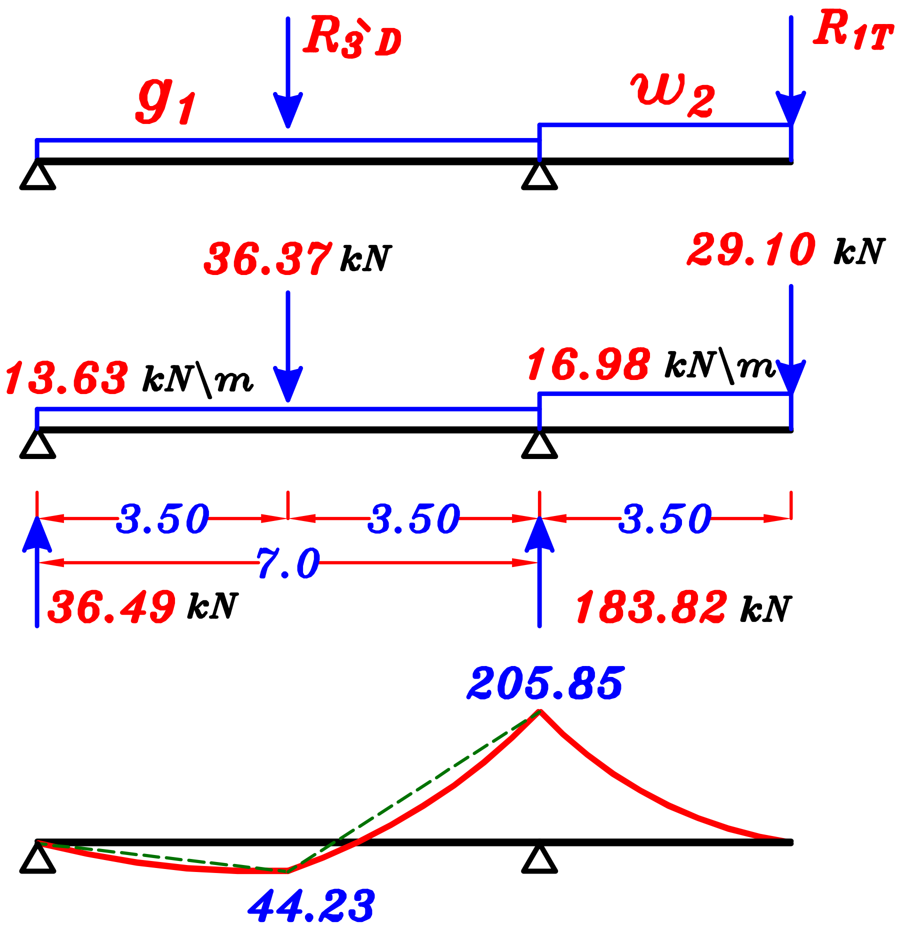
$$w_2 = g_2 + p_2 = 13.63 + 3.35 = 16.98 \; kN\backslash m$$

max−max B.M.D. For the girder (G_1)

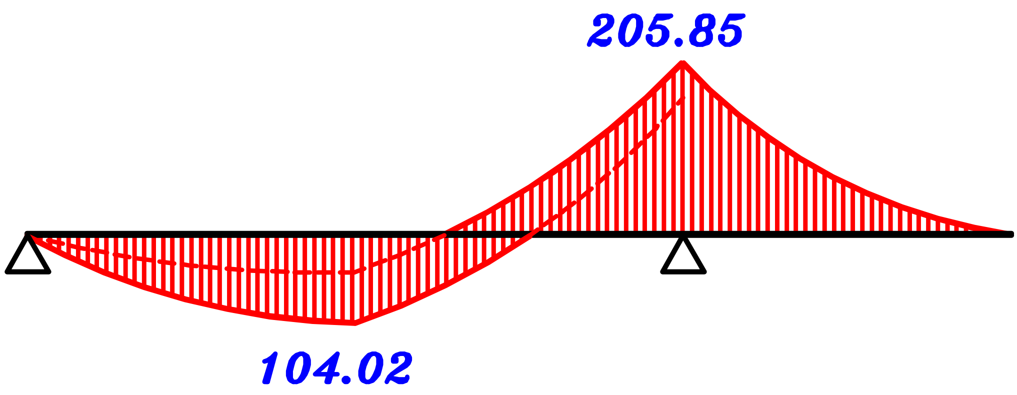
1- max. +ve B.M.D.



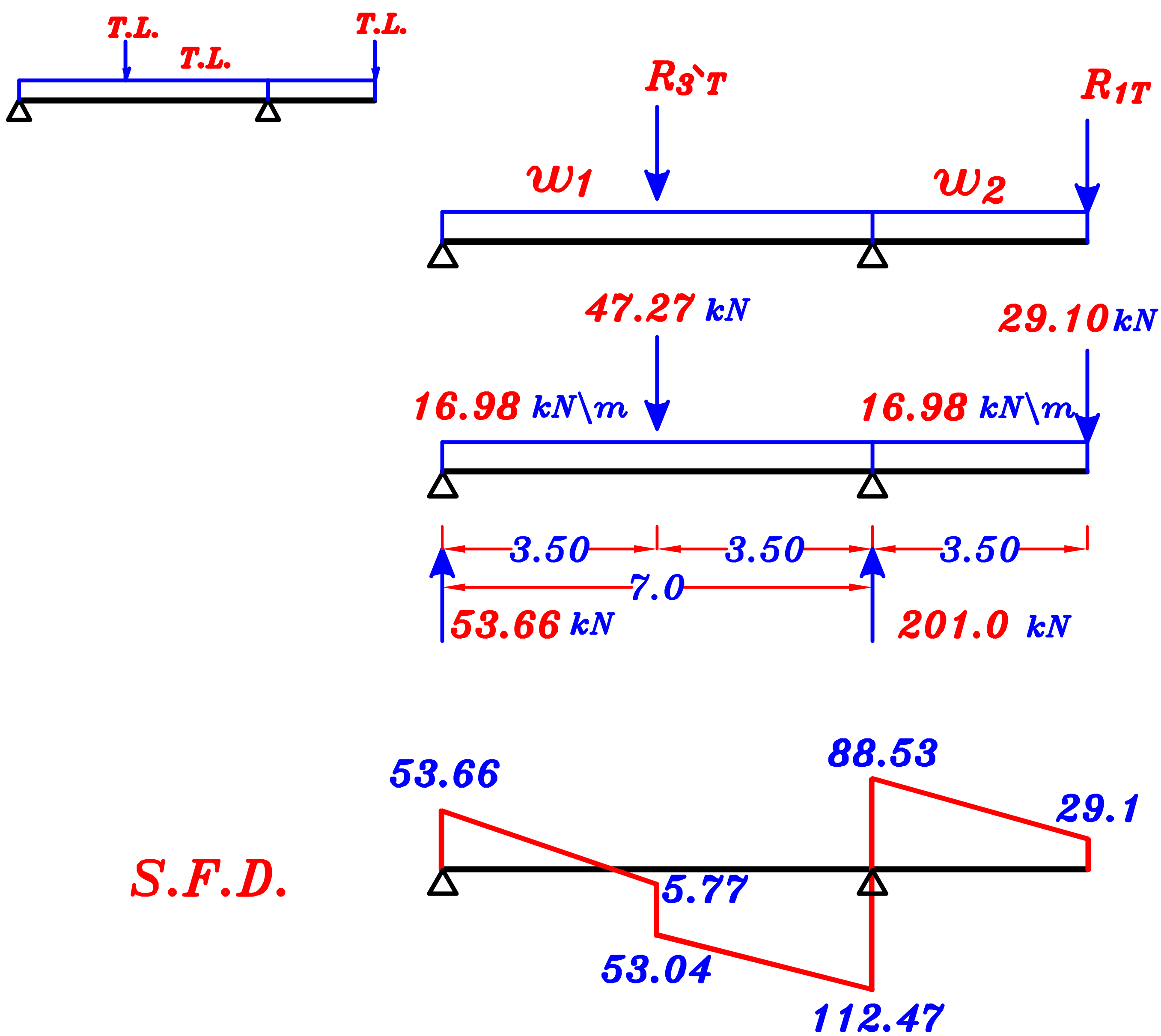
2- max. −ve B.M.D.



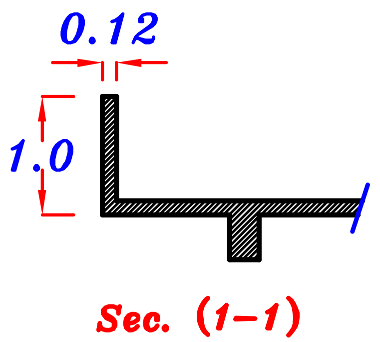
max–max B.M.D. For the girder (G_1)

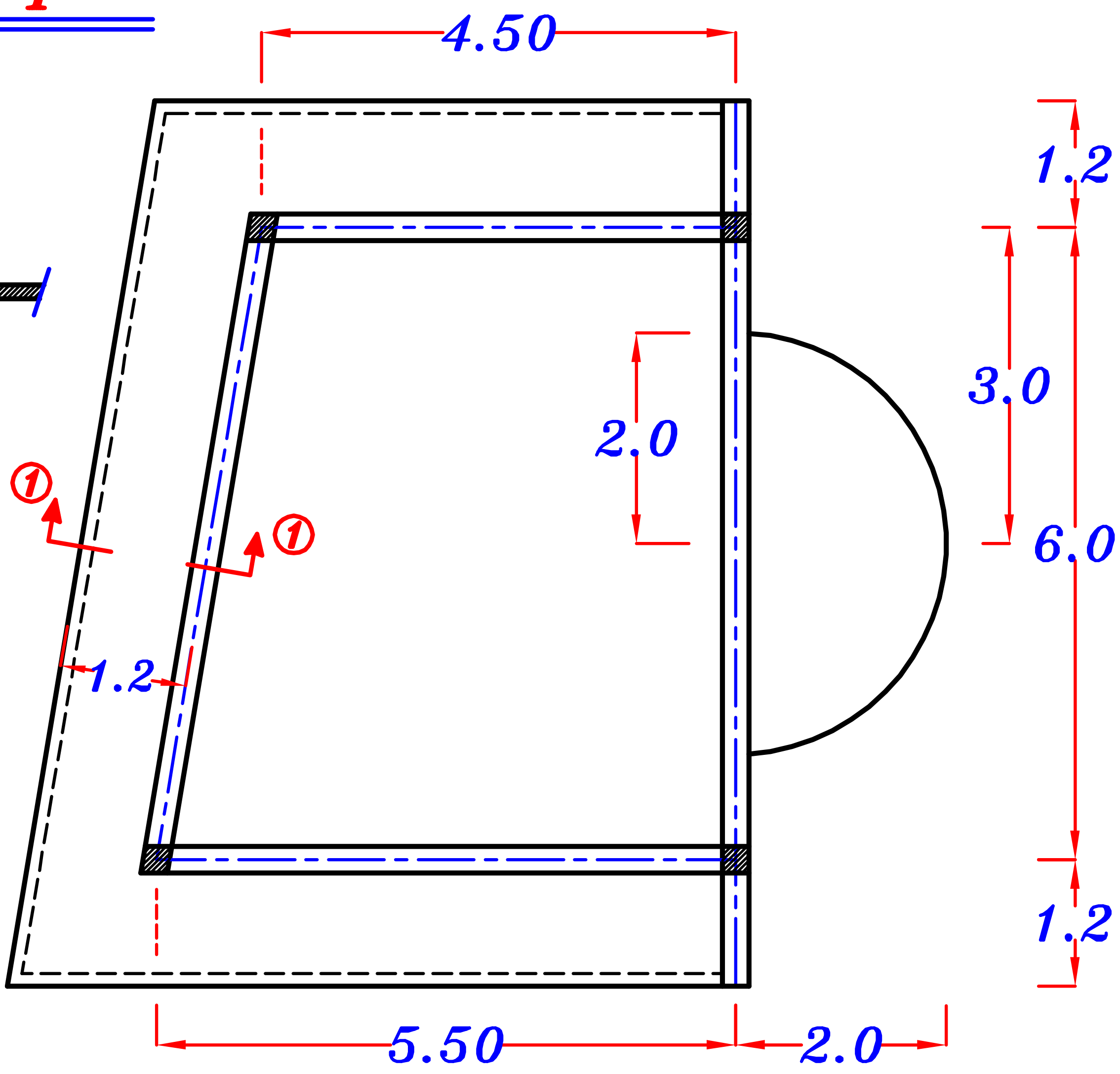


S.F.D. For the girder (G_1)



Example.





Data.

$t_s = 0.16\ m$

$F.C. = 1.50\ kN\backslash m^2$

$L.L. = 3.0\ kN\backslash m^2$

b (*Beams & Girders*) $= 0.25\ m$

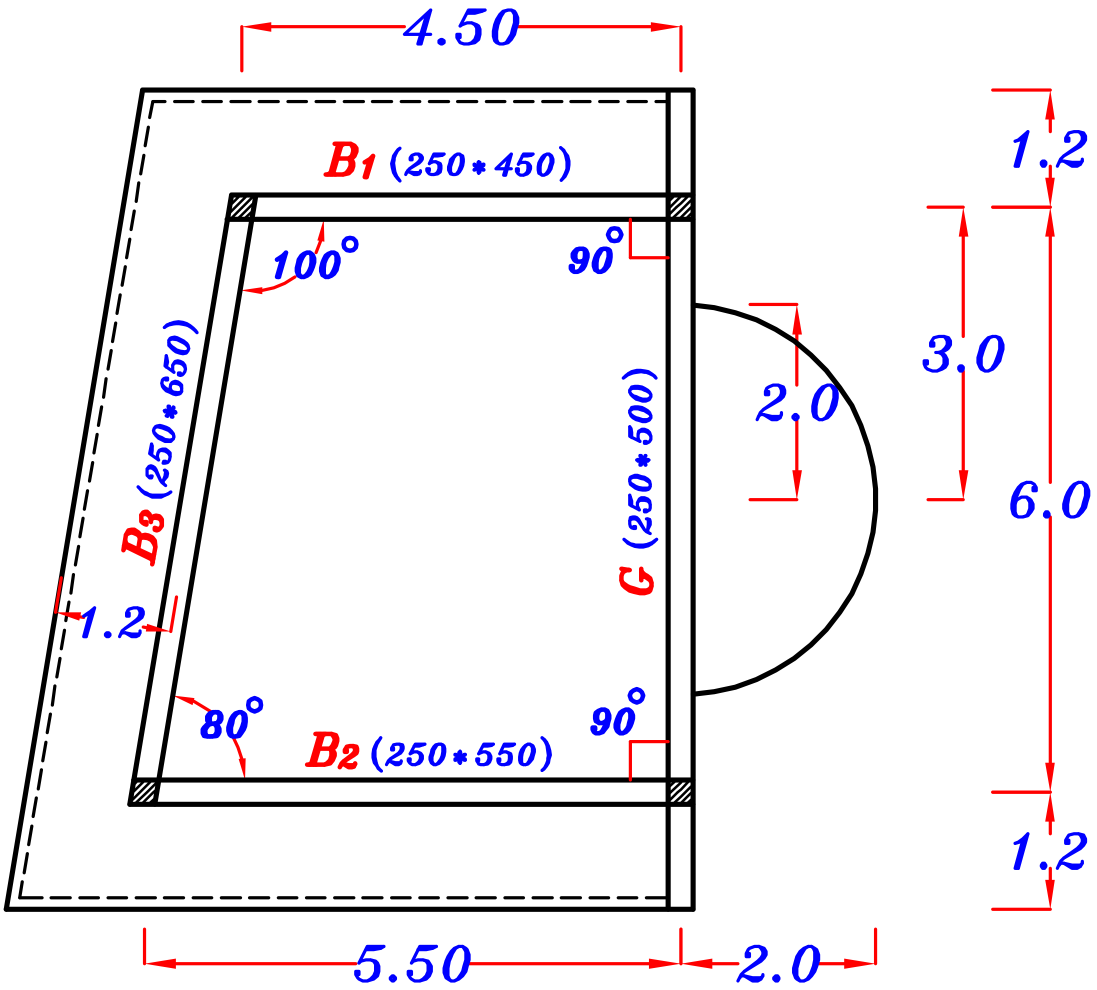
O.W. of beams & girders are reasonably assumed according to the expected depth.

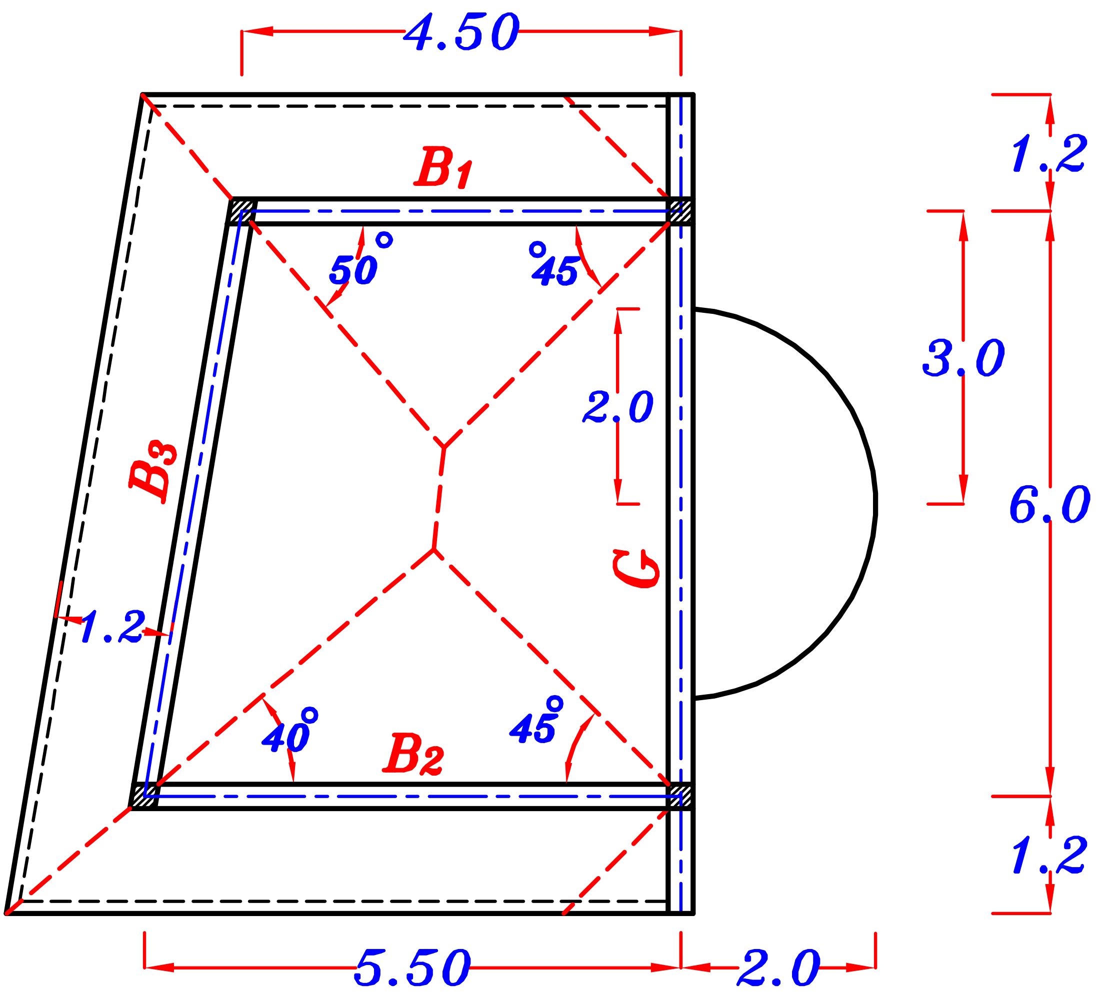
Req.

1- Draw the structural plan showing the pattern of Load Distribution.

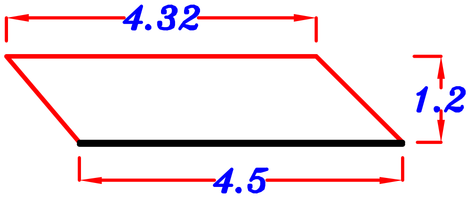
2- Calculate the equivalent load For shear and bending For all beams.

3- Draw S.F.D. & Absolute B.M.D. For the Girder.

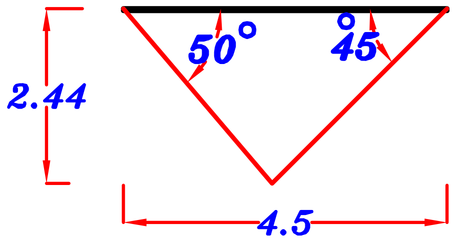

4.50
B1 (250*450)
100°
90°
B3 (250*650)
G (250*500)
2.0
3.0
6.0
1.2
1.2
80°
90°
B2 (250*550)
1.2
5.50
2.0


4.50
B1
50°
45°
B3
2.0
3.0
6.0
1.2
G
1.2
40°
45°
B2
1.2
5.50
2.0

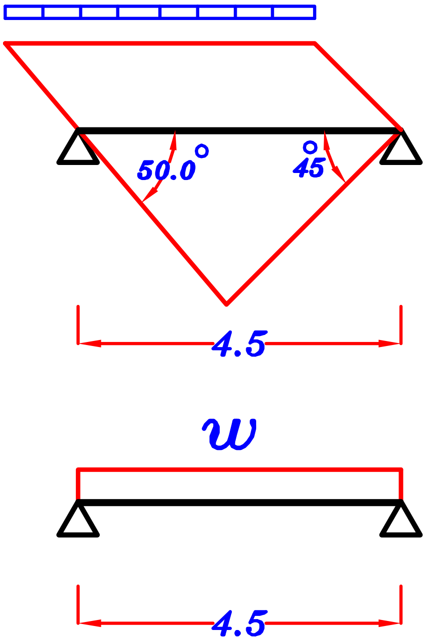
B_1

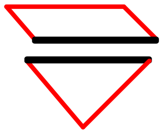


$area = 5.29\ m^2$



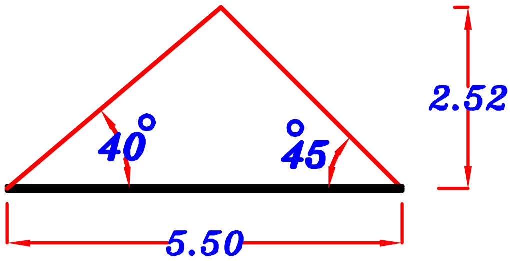
$area = 5.49\ m^2$



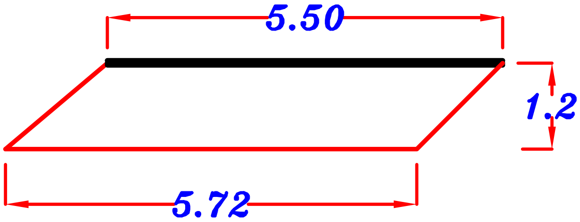


$$w = 0.w + \frac{\sum area}{Span = 4.50\ m} * w_s + \frac{\sum weight = b\,h\,\gamma_c * 4.32\ m}{Span = 4.50\ m}$$

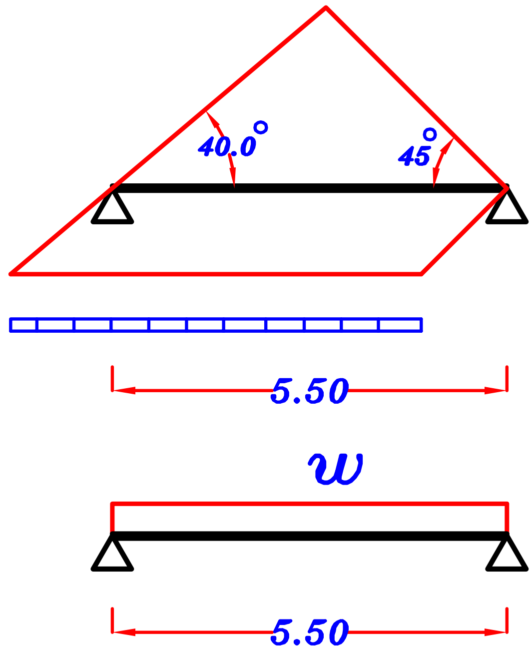
B_2

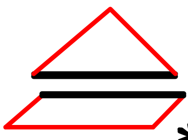


$area = 6.93\ m^2$



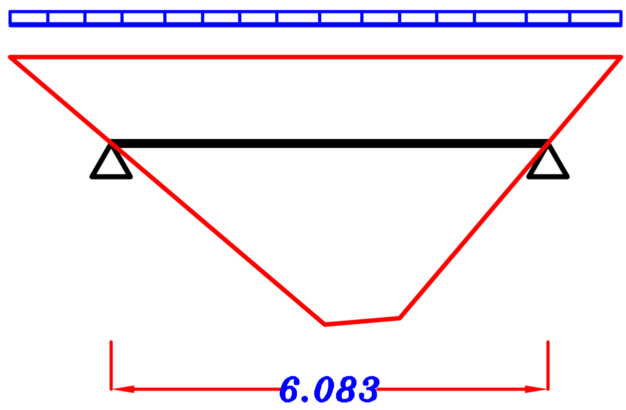
$area = 6.732\ m^2$

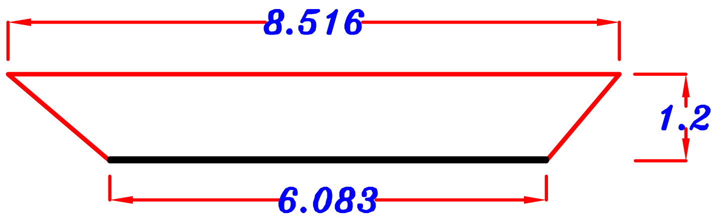




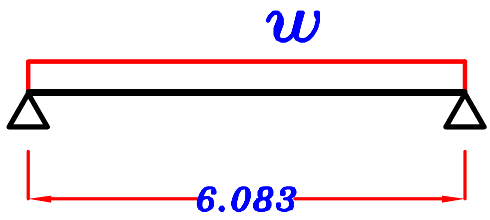
$$w = 0.w + \frac{\sum area}{Span = 5.50\ m} * w_s + \frac{\sum weight = b\,h\,\gamma_c * 5.72\ m}{Span = 5.50\ m}$$

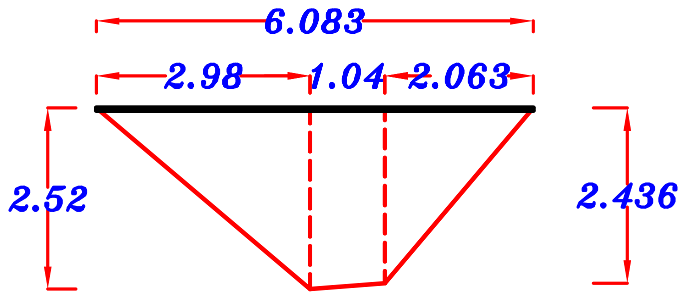
B_3





$area = 8.759\ m^2$

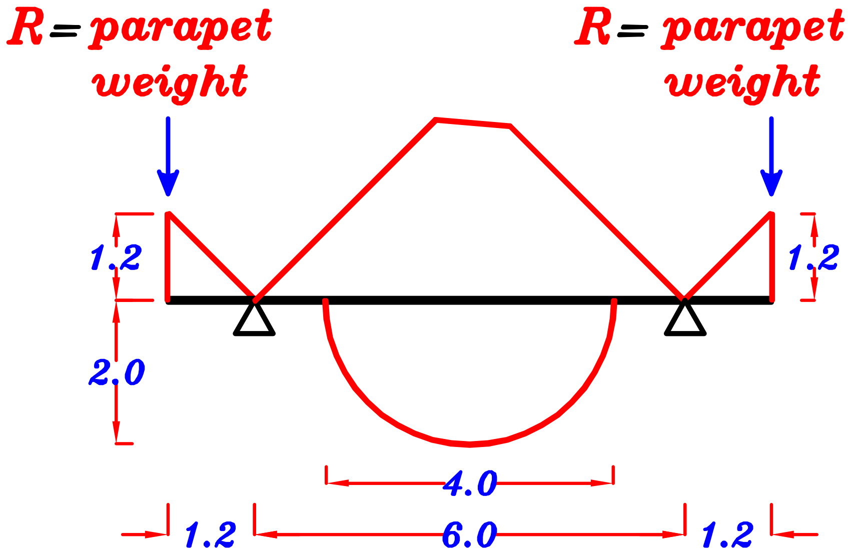




$area = 8.844\ m^2$

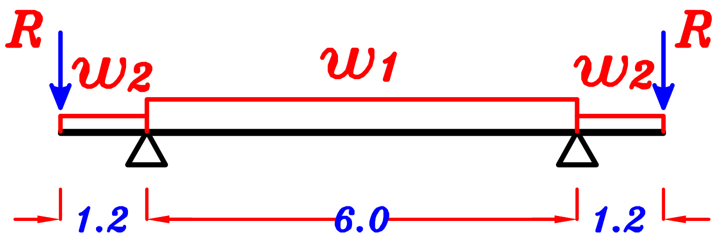
$$w = o.w + \frac{\sum area}{Span = 6.083\ m} * w_s + \frac{\sum weight = b\, h\, \gamma_c * 8.516\ m}{Span = 6.083\ m}$$

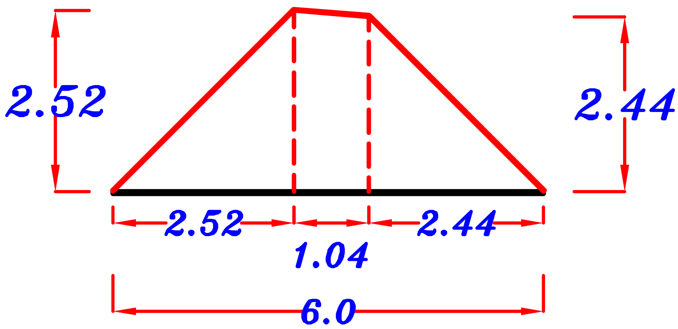
G



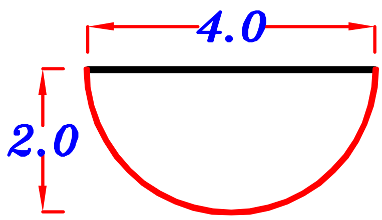
parapet weight

$$R = b\,h\,\gamma_c * 1.20\ m$$

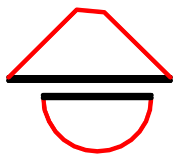




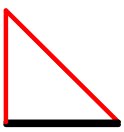
area = 8.731 m^2



area = 6.283 m^2

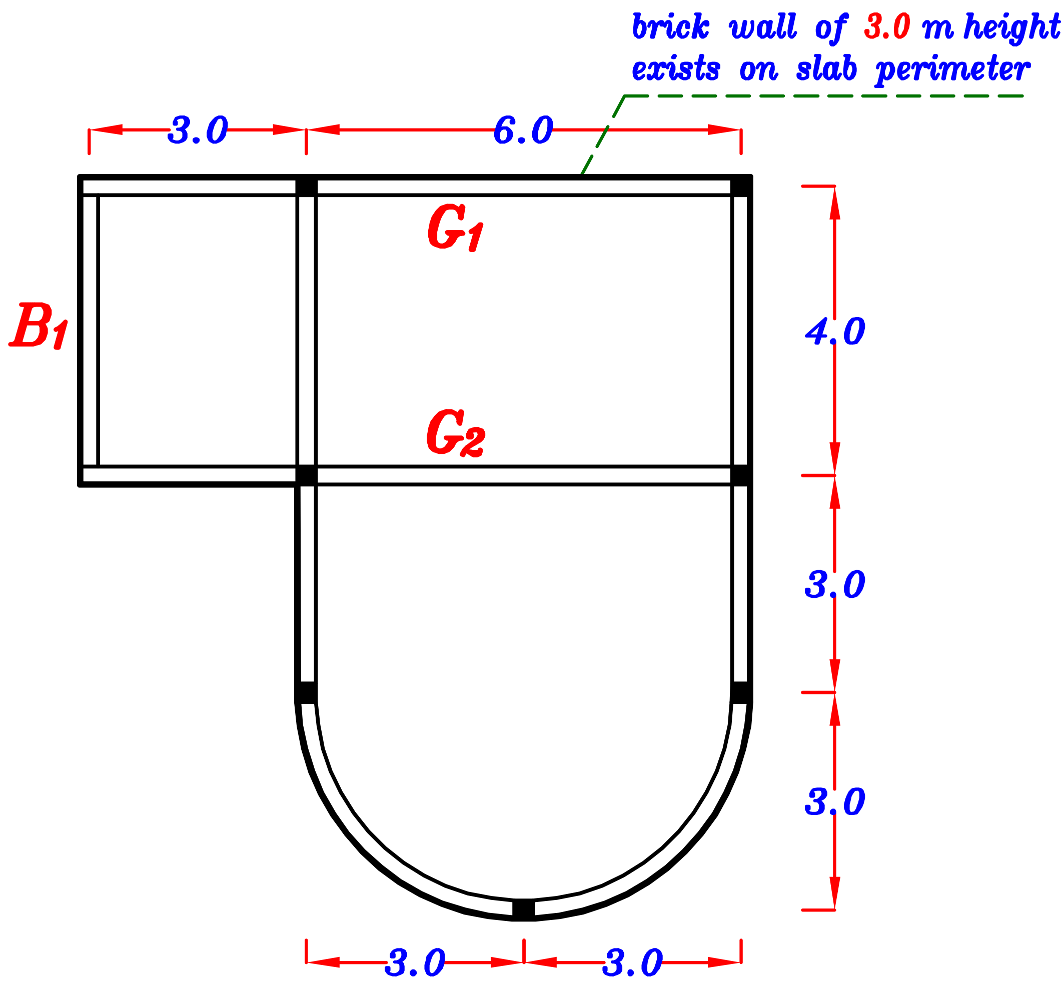


$$w_1 = o.w + \frac{\sum area}{Span = 6.0\ m} * w_s$$



$$w_2 = o.w + C_a\, w_s\, L_c$$

Example.

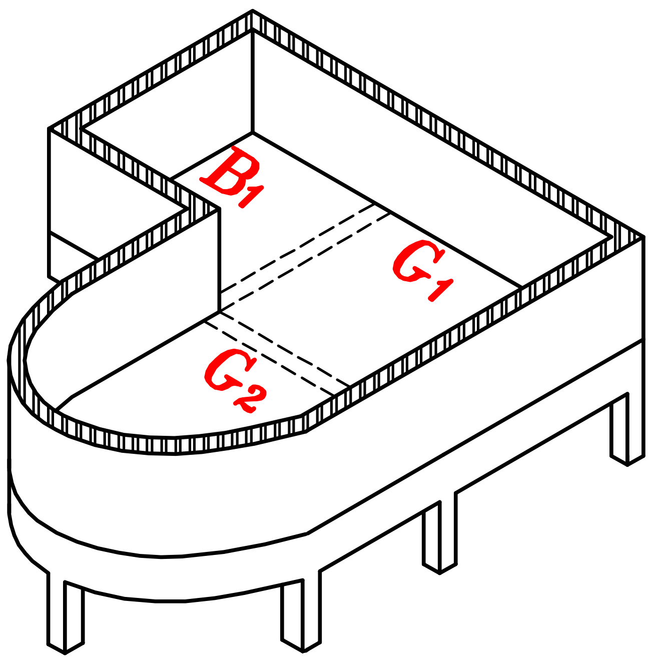


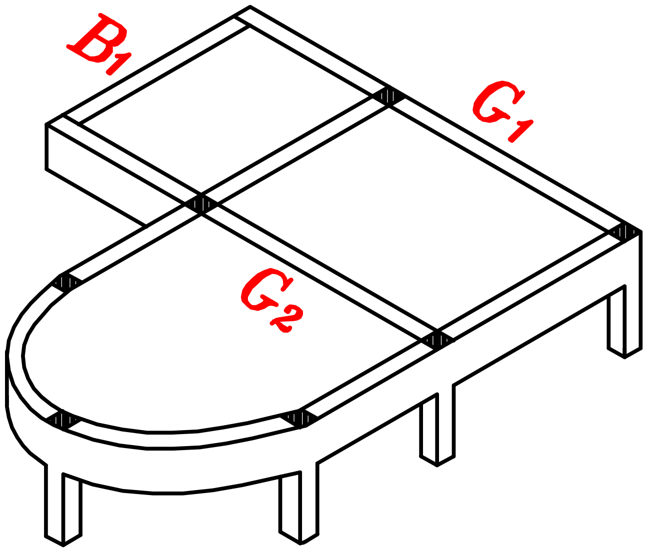
مطلوب حساب w_e و w_a لكل الكمرات .

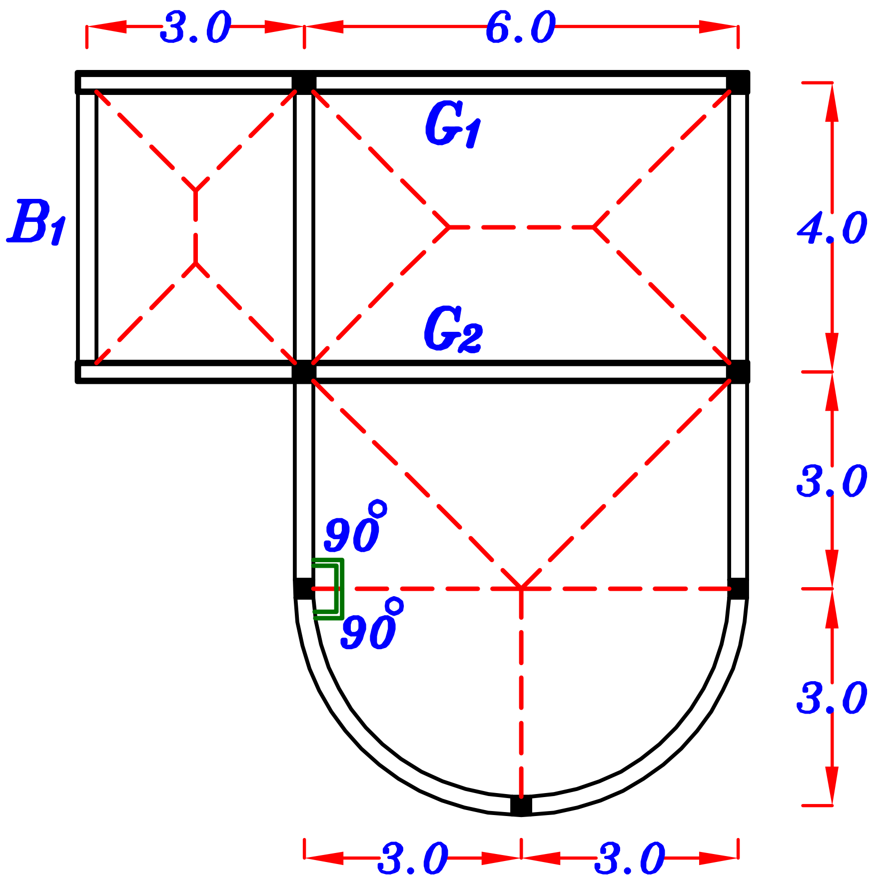
و مطلوب رسم max–max B.M.D. للـ girder G_1 , G_2

لذا سنحسب الـ Reactions فقط للكمرات المحموله على الـ Girders

الحائط على المحيط الخارجي فقط







$F.C. = 2.0 \ kN\backslash m^2$

$L.L. = 2.0 \ kN\backslash m^2$

$\gamma_{wall} = 18.0 \ kN\backslash m^3$

$b_{wall} = 0.25 \ m$

$H_{wall} = 3.0 \ m$

$$g_s = t_s * \gamma_c + F.C. = 0.16 * 25 + 2.0 = 6.0 \ kN\backslash m^2$$

$$p_s = L.L. = 2.0 \ kN\backslash m^2$$

B_1

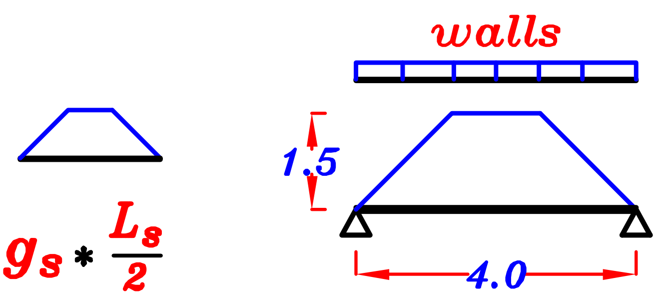
$b * h_w * \gamma_w$

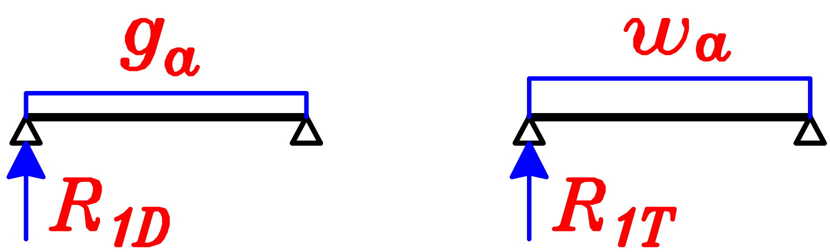
$0.25 * 3.0 * 18.0$

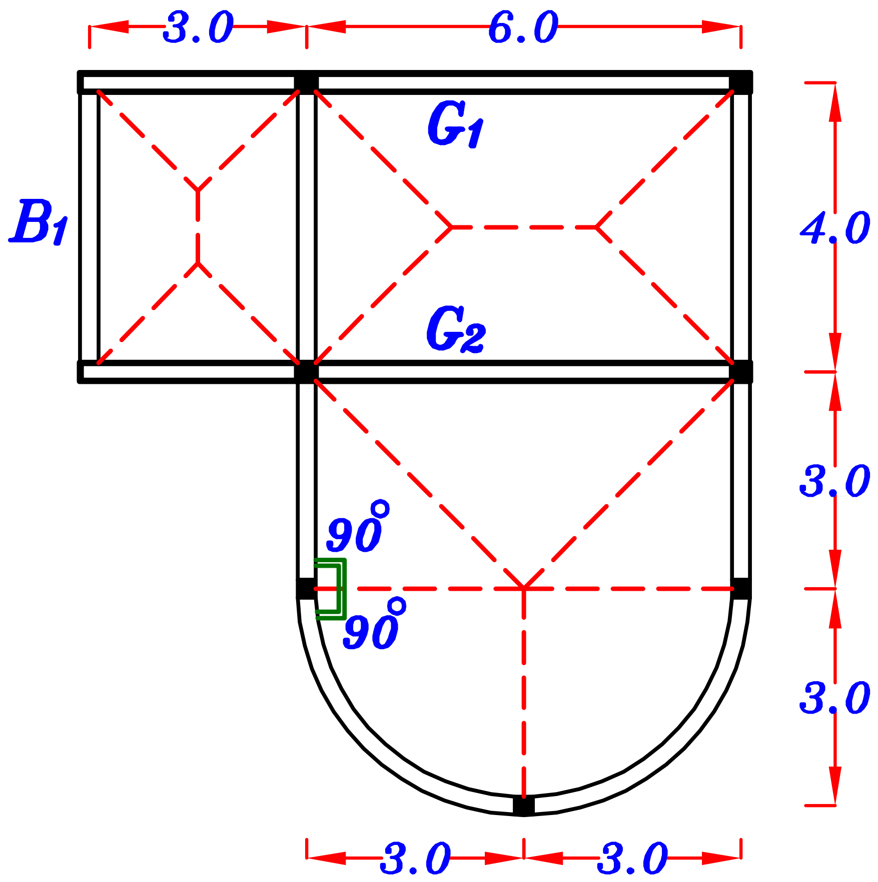
$$g_a = o.w. + walls + C_a * g_s * \frac{L_s}{2}$$

$$p_a = C_a * p_s * \frac{L_s}{2}$$

$$w_a = g_a + p_a$$







G_1

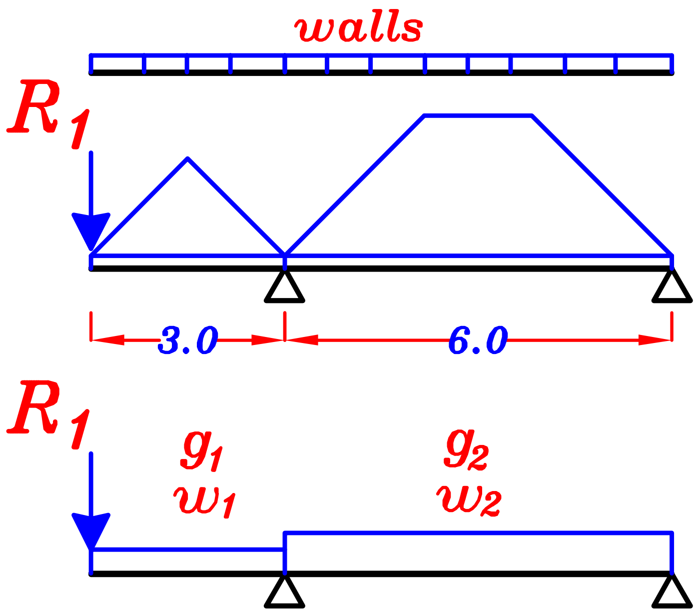
$$b * h_w * \gamma_w$$

$$0.25 * 3.0 * 18.0$$

$$g_1 = o.w. + wall + C_e\, g_s * \frac{Lc}{2}$$

$$p_1 = C_e\, p_s * \frac{Lc}{2}$$

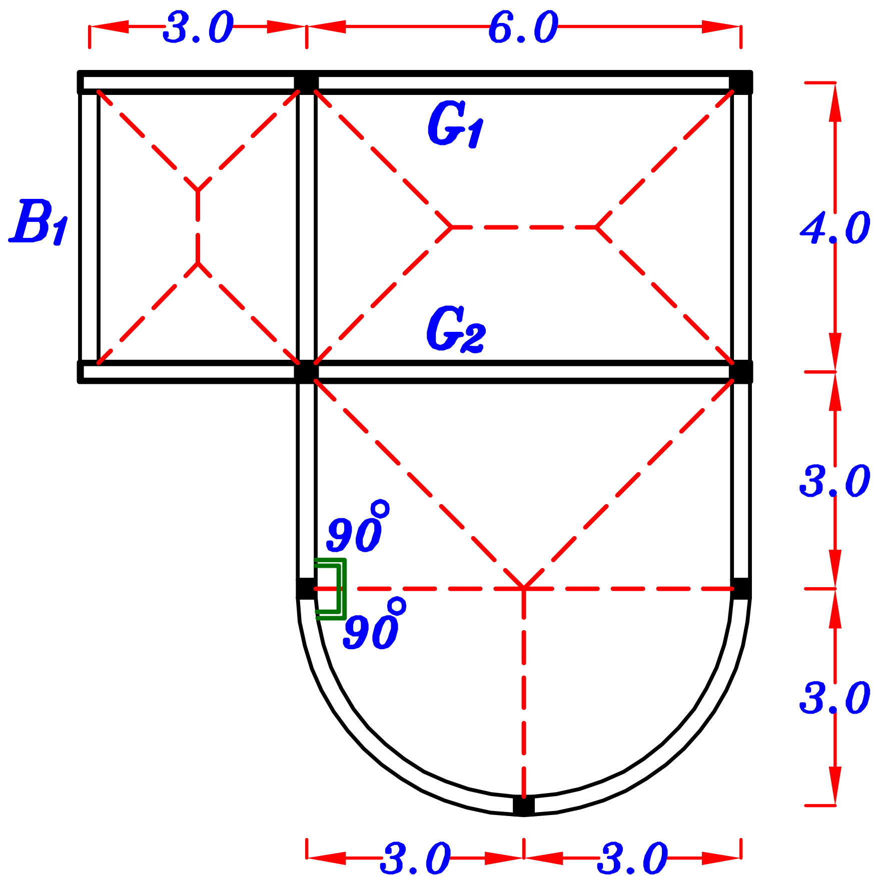
$$w_1 = g_1 + p_1$$



$$g_2 = o.w. + wall + C_e\, g_s * \frac{Ls}{2}$$

$$p_2 = C_e\, p_s * \frac{Ls}{2}$$

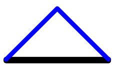
$$w_2 = g_2 + p_2$$

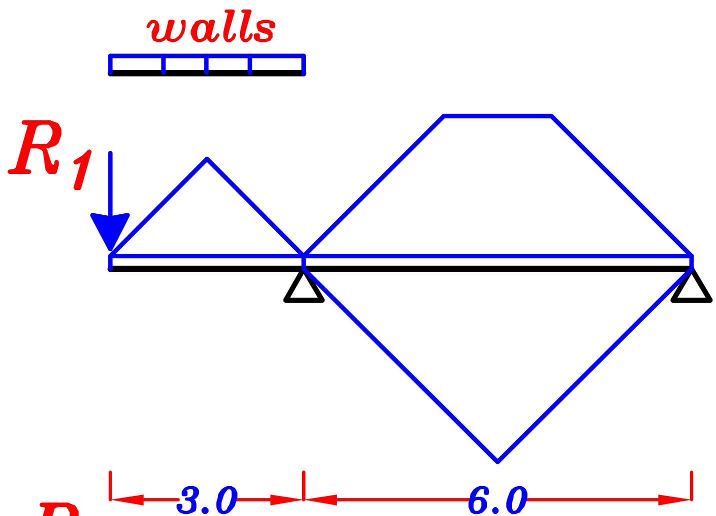


$\underline{\underline{G_2}}$

$$b * h_w * \gamma_w$$

$$0.25 * 3.0 * 18.0$$

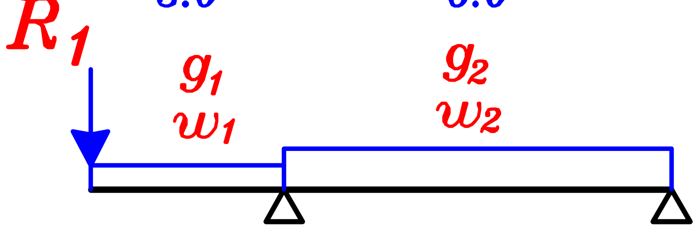


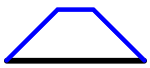


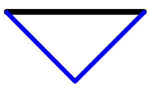
$$g_1 = o.w. + wall + C_e\ g_s * \frac{Lc}{2}$$

$$p_1 = C_e\ p_s * \frac{Lc}{2}$$

$$w_1 = g_1 + p_1$$





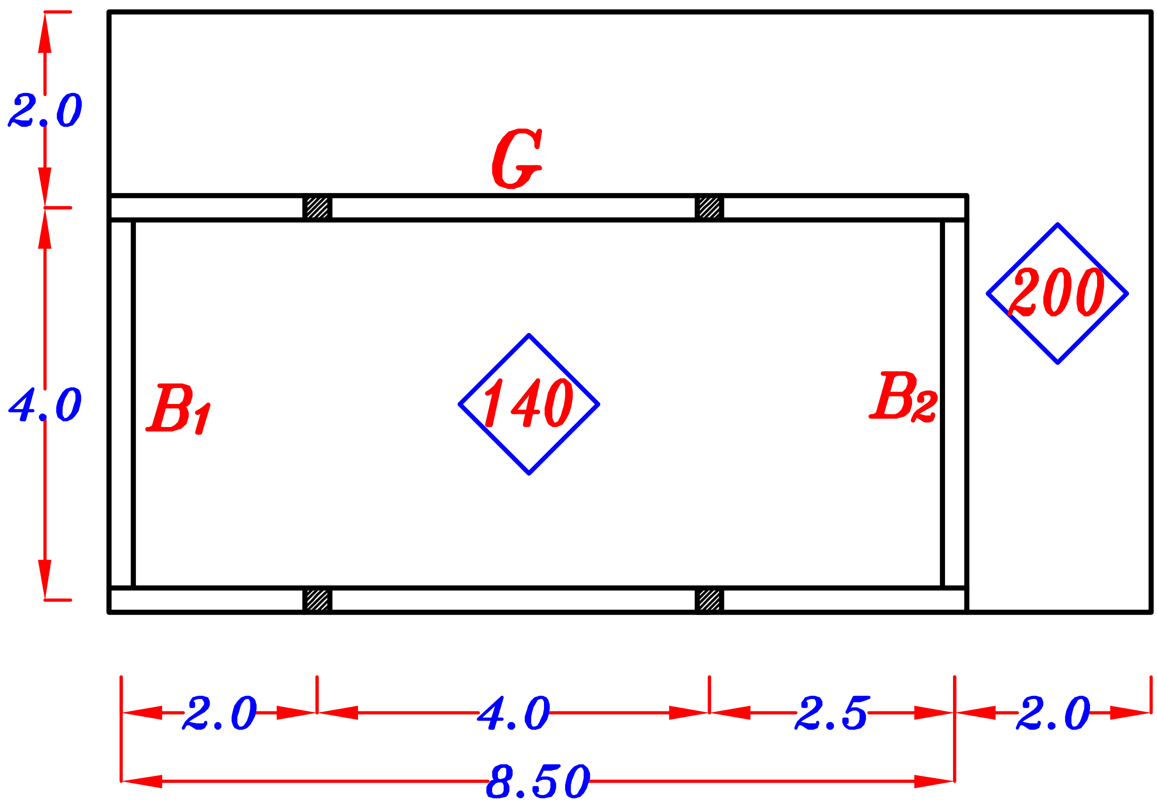


$$g_2 = o.w. + C_e\ g_s * \frac{Ls}{2} + C_e\ g_s * H$$

$$p_2 = C_e\ p_s * \frac{Ls}{2} + C_e\ p_s * H$$

$$w_2 = g_2 + p_2$$

Example.



$F.C. = 1.5 \ kN\backslash m^2$

$L.L. = 2.0 \ kN\backslash m^2$

For $t_s = 140$ mm

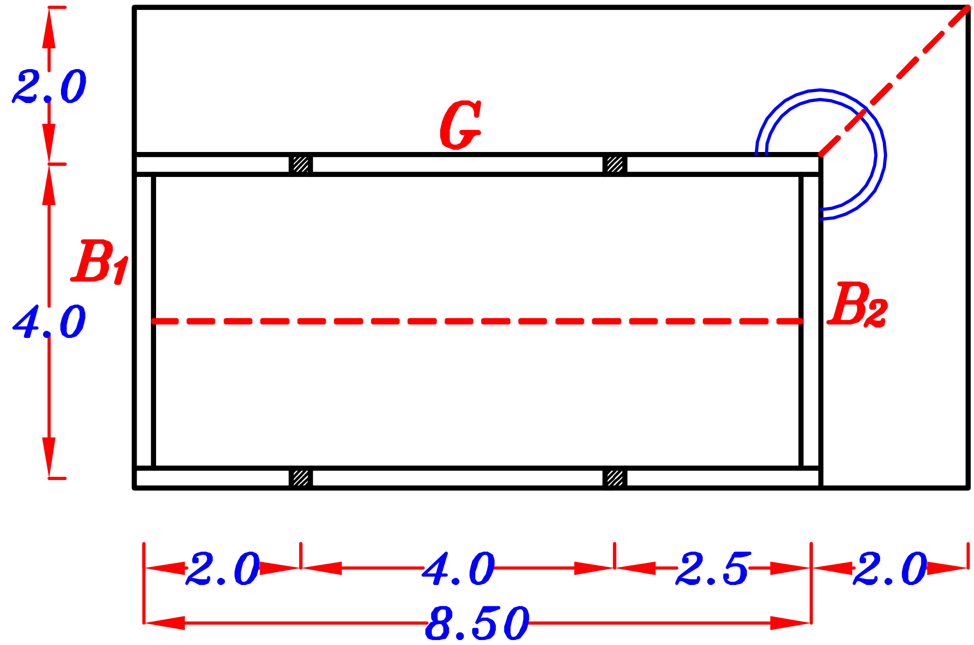
$$g_{s1} = t_{s1} * \gamma_c + F.C. = 0.14 * 25 + 1.50 = 5.0 \ kN\backslash m^2$$

$$p_s = L.L. = 2.0 \ kN\backslash m^2$$

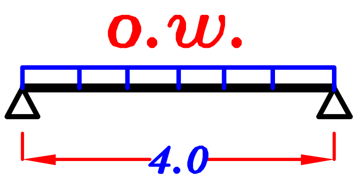
For $t_s = 200$ mm

$$g_{s2} = t_{s2} * \gamma_c + F.C. = 0.20 * 25 + 1.50 = 6.50 \ kN\backslash m^2$$

$$p_s = L.L. = 2.0 \ kN\backslash m^2$$

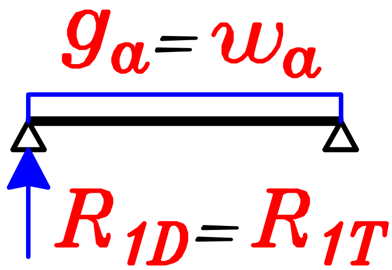


B_1

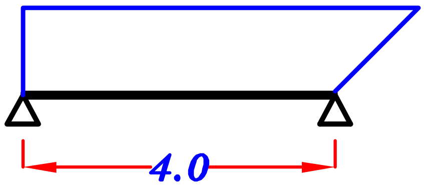


$$g_a = o.w. \qquad p_a = zero$$

$$w_a = g_a + p_a = g_a$$



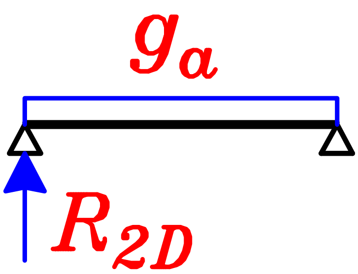
B_2

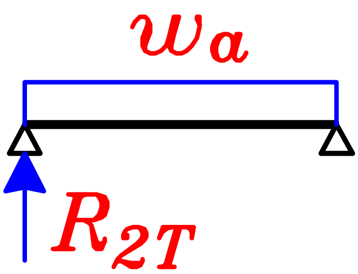


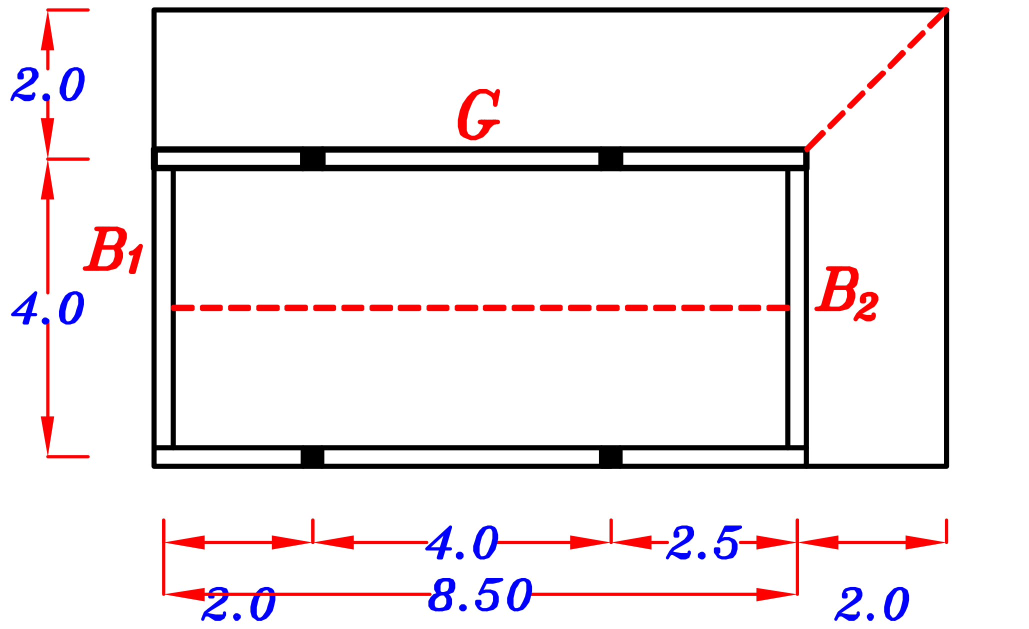
$$g_a = o.w. + \frac{\sum area}{Span} * g_{s2}$$

$$p_a = \frac{\sum area}{Span} * p_s$$

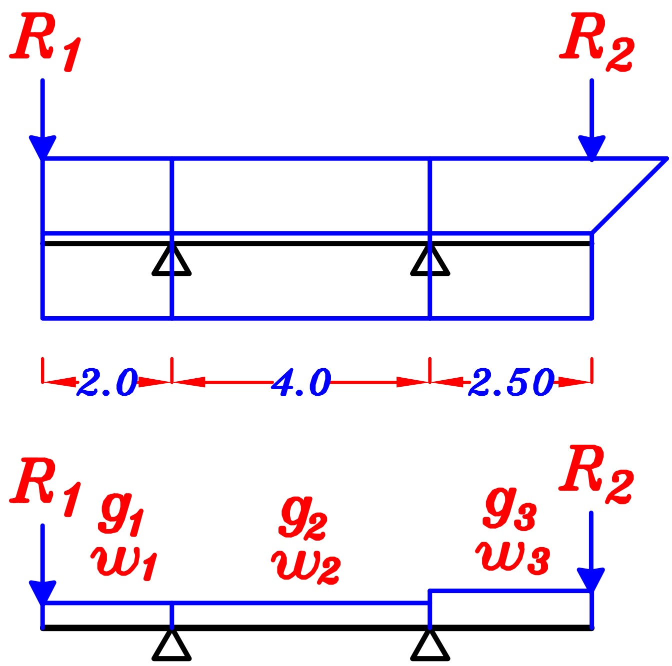
$$w_a = g_a + p_a$$







$\underline{\underline{G}}$



$$g_1 = g_2 = o.w. + g_{s1} * \frac{L_s}{2} + g_{s2} * L_c$$

$$p_1 = p_2 = p_s * \frac{L_s}{2} + p_s * L_c$$

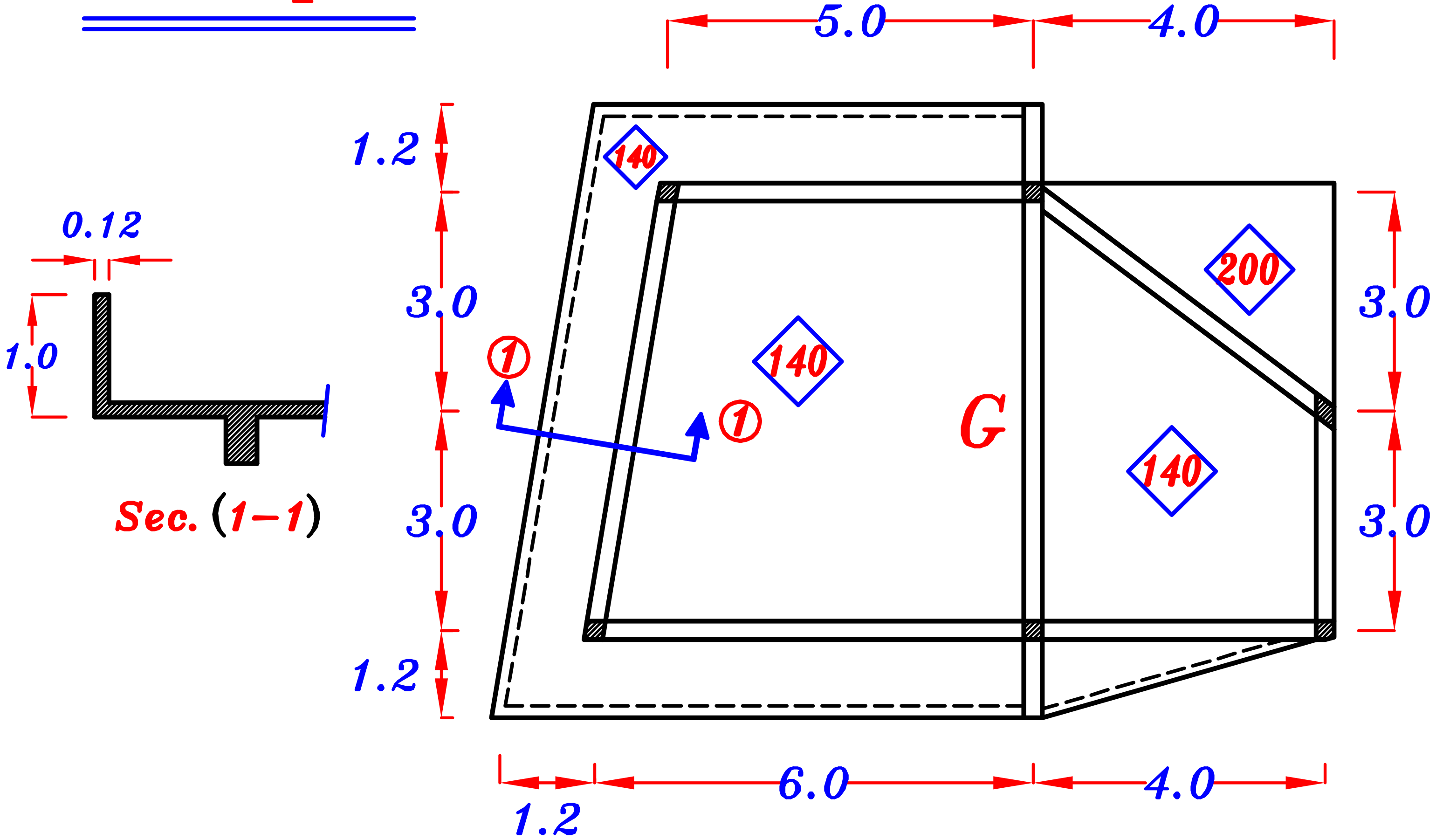
$$w_1 = w_2 = g_1 + p_1$$

$$g_3 = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\sum area}{Span} * g_{s2}$$

$$p_3 = p_s * \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_3 = g_3 + p_3$$

Example.



$F.C. = 1.5 \ kN\backslash m^2$

$L.L. = 3.0 \ kN\backslash m^2$

$\text{Fence weight} = b \, h \, \gamma_c$

$= 0.12 * 1.0 * 25 \ (kN/m')$

For $t_s = 140 \ mm$

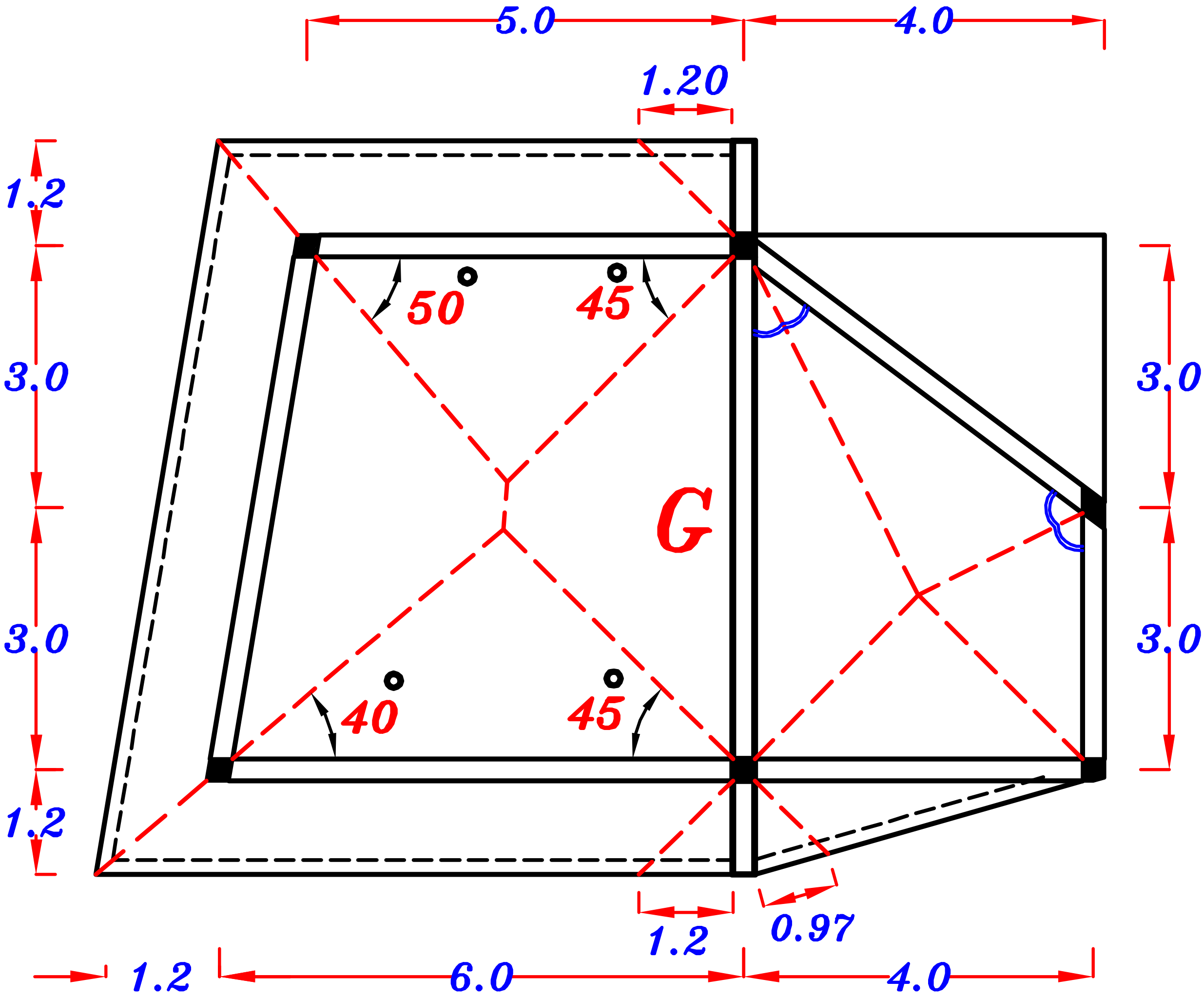
$$g_{s1} = t_{s1} * \gamma_c + F.C. = 0.14 * 25 + 1.50 = 5.0 \ kN\backslash m^2$$

$$p_s = L.L. = 3.0 \ kN\backslash m^2$$

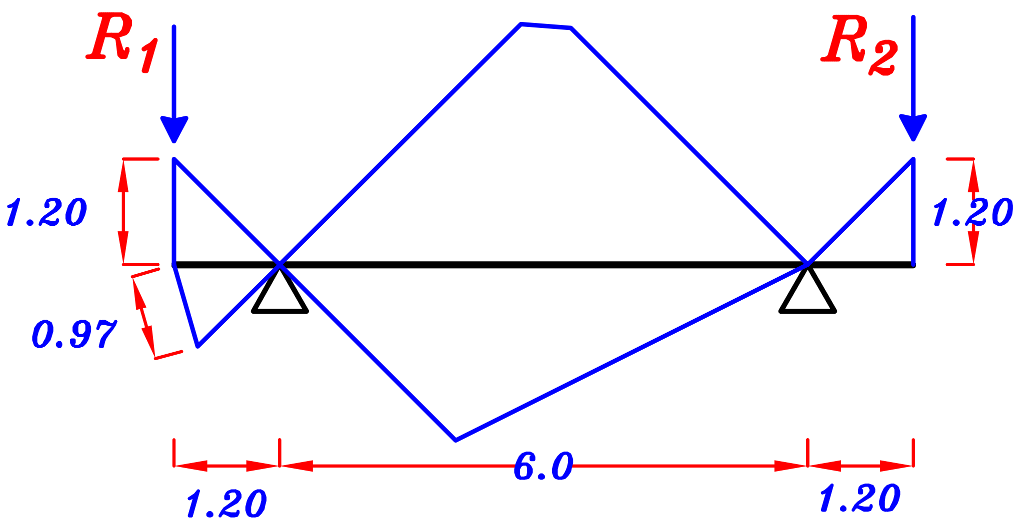
For $t_s = 200 \ mm$

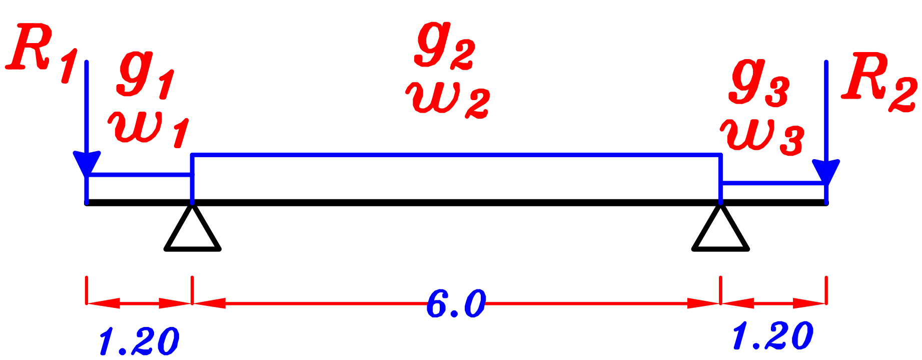
$$g_{s2} = t_{s2} * \gamma_c + F.C. = 0.20 * 25 + 1.50 = 6.50 \ kN\backslash m^2$$

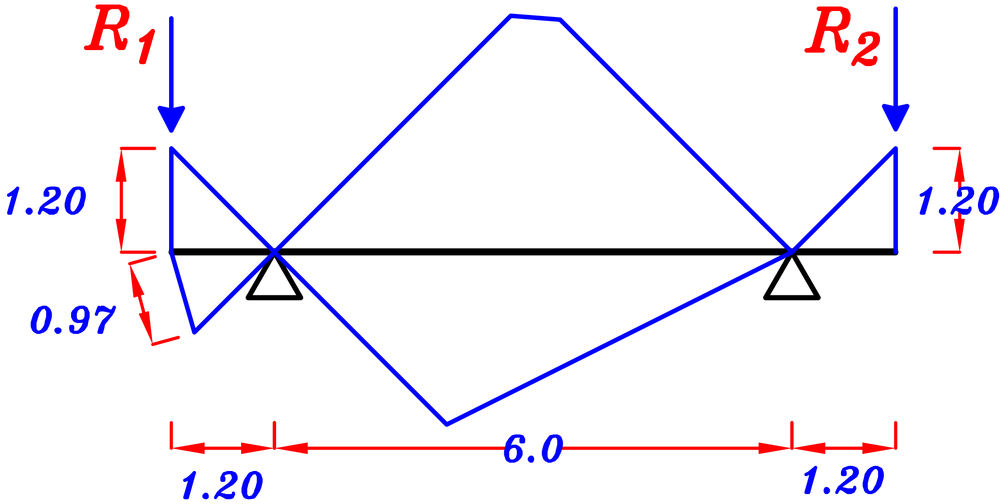
$$p_s = L.L. = 3.0 \ kN\backslash m^2$$

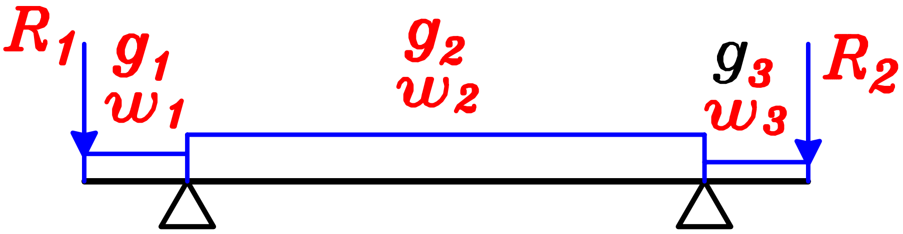


ممكن قياس اى بعد من على الرسمه اذا كانت مرسومه **to scale**









$$R_1 = b\,h\,\gamma_c * (1.2 + 0.97) \quad , \quad R_2 = b\,h\,\gamma_c * (1.2)$$

$$g_1 = o.w. + C_e\, g_{s1} * L_c + \frac{\sum area}{Span} * g_{s1}$$

$$p_1 = C_e\, p_s * L_c + \frac{\sum area}{Span} * p_s$$

$$w_1 = g_1 + p_1$$

$$g_2 = o.w. + \frac{\sum area}{Span} * g_{s1}$$

$$p_2 = \frac{\sum area}{Span} * p_s$$

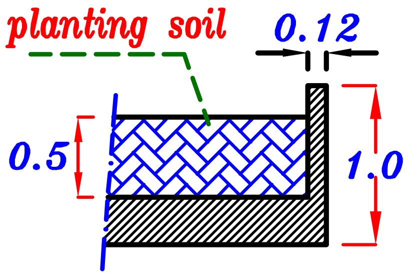
$$w_2 = g_2 + p_2$$

$$g_3 = o.w. + C_e\, g_{s1} * L_c$$

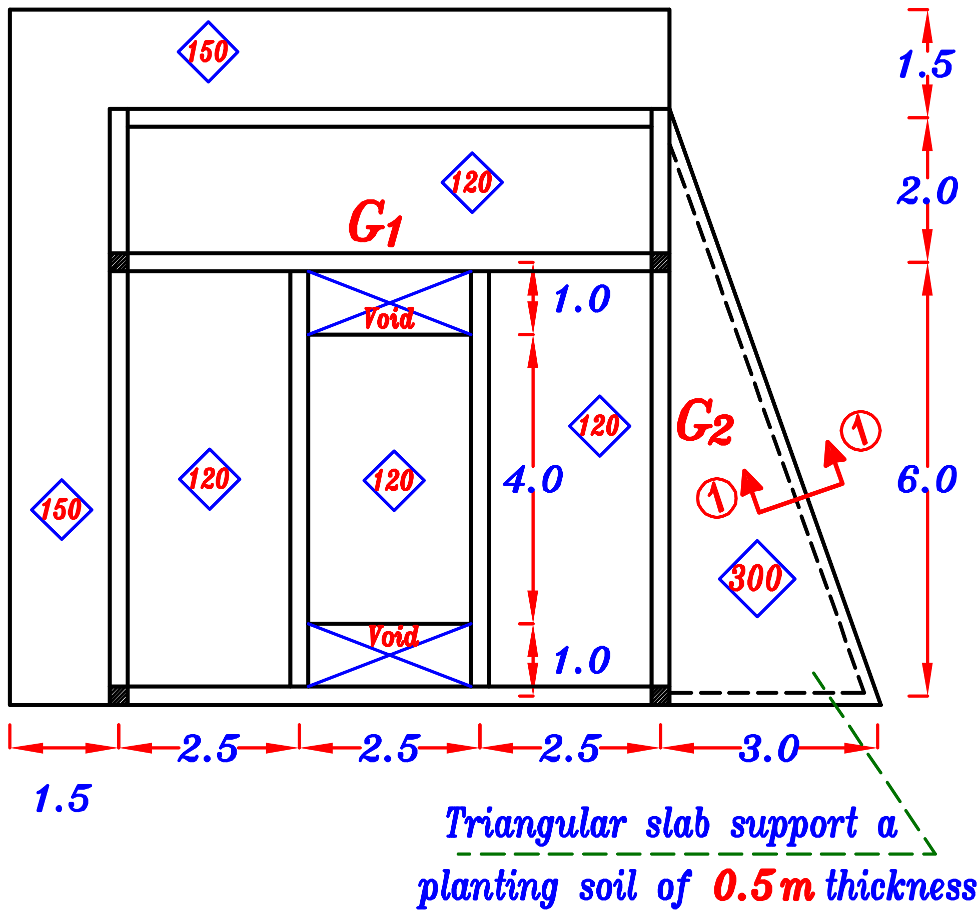
$$p_3 = C_e\, p_s * L_c$$

$$w_3 = g_3 + p_3$$

Example.



Sec. (1−1)



$\gamma_{soil} = 20 \; kN/m^3$

$F.C. = 1.5 \; kN \backslash m^2$

$L.L. = 3.0 \; kN \backslash m^2$

$Fence\ weight = b\, h\, \gamma_c = 0.12 * 1.0 * 25 \; (kN/m')$

For $t_s = 120$ mm

$g_{s1} = t_{s1} * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.5 \; kN \backslash m^2$

$p_s = L.L. = 3.0 \; kN \backslash m^2$

For $t_s = 150$ mm

$g_{s2} = t_{s2} * \gamma_c + F.C. = 0.15 * 25 + 1.50 = 5.25 \; kN \backslash m^2$

$p_s = L.L. = 3.0 \; kN \backslash m^2$

For $t_s = 300$ mm

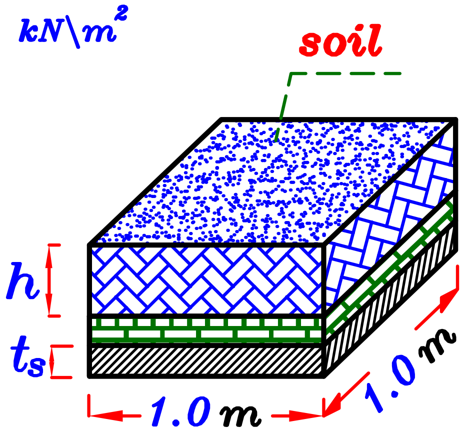
عزل رطوبه

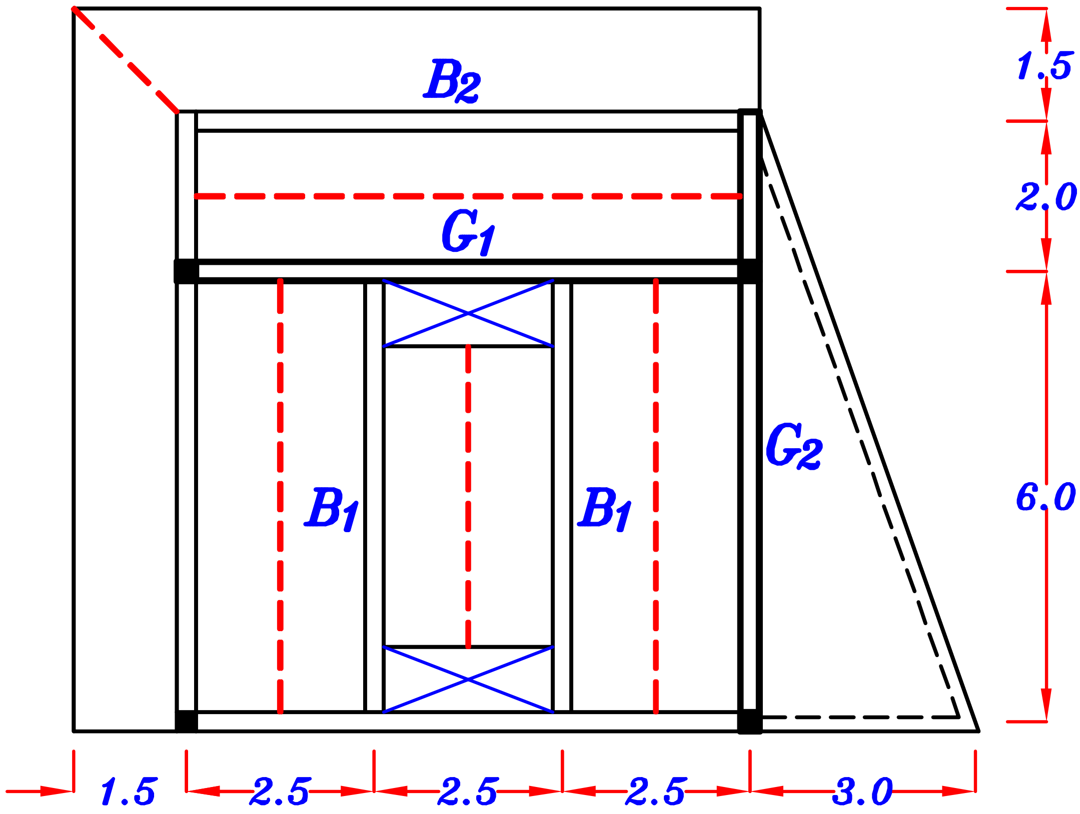
$h\,(1.0 * 1.0)\, \gamma_{soil}$

$g_{s3} = t_{s3} * \gamma_c + F.C. + Soil$

$= 0.30 * 25 + 1.50 + 0.5 * 20 = 19.0 \; kN \backslash m^2$

$p_s = L.L. = 3.0 \; kN \backslash m^2$



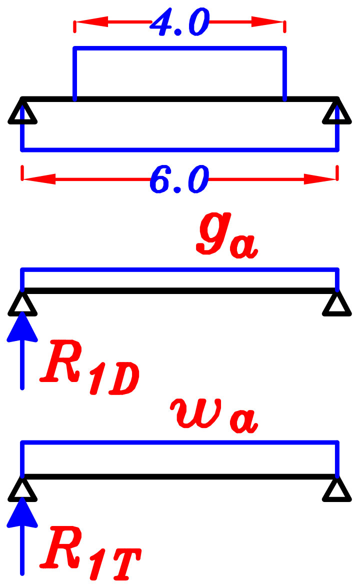


$\underline{\underline{B_1}}$

$$g_a = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\sum area}{Span} * g_{s1}$$

$$p_a = p_s * \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_a = g_a + p_a$$

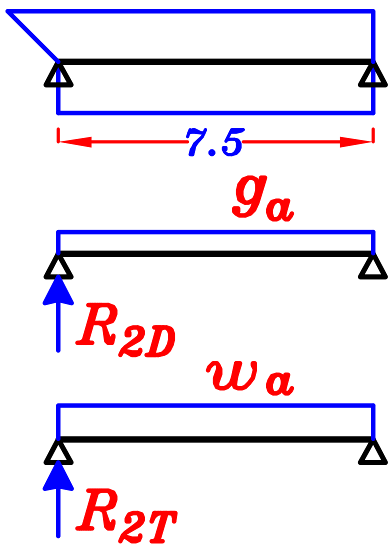


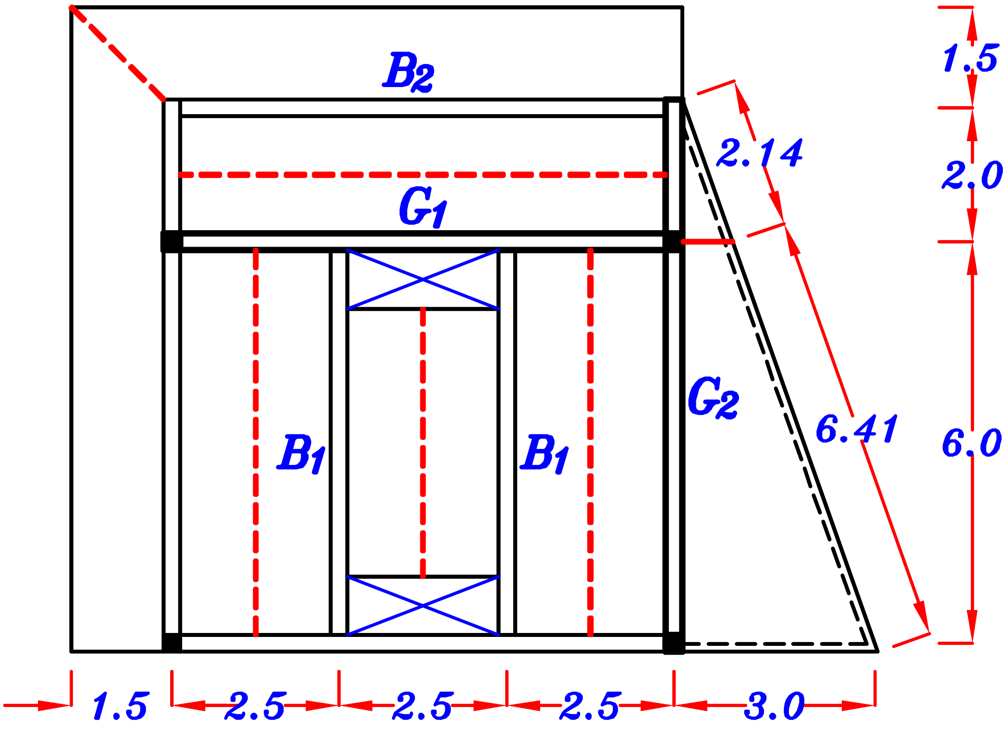
$\underline{\underline{B_2}}$

$$g_a = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\sum area}{Span} * g_{s2}$$

$$p_a = p_s * \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_a = g_a + p_a$$



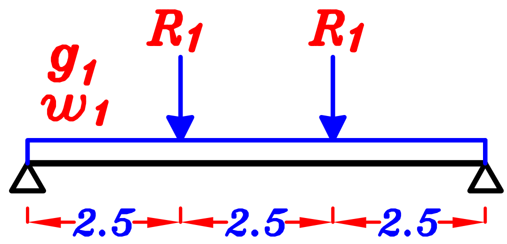


G_1

$$g_1 = o.w. + \; g_{s1} * \frac{L_s}{2}$$

$$p_1 = \; p_s * \frac{L_s}{2}$$

$$w_1 = g_1 + p_1$$



G_2

Fence weight

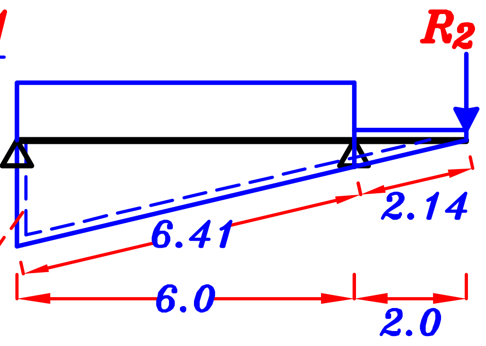
$$b h \gamma_c * 6.41$$

$$g_1 = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\sum area}{Span} * g_{s3} + \frac{\sum weight}{Span}$$

$$p_1 = \; p_s * \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_1 = g_1 + p_1$$

وزن هذا الجزء يذهب
مباشره الى العمود

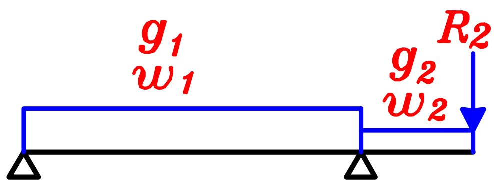


$$b h \gamma_c * 2.14$$

$$g_2 = o.w. + \frac{\sum area}{Span} * g_{s3} + \frac{\sum weight}{Span}$$

$$p_2 = \frac{\sum area}{Span} * p_s$$

$$w_2 = g_2 + p_2$$

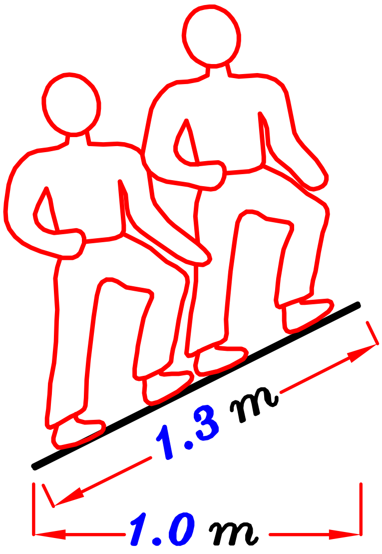


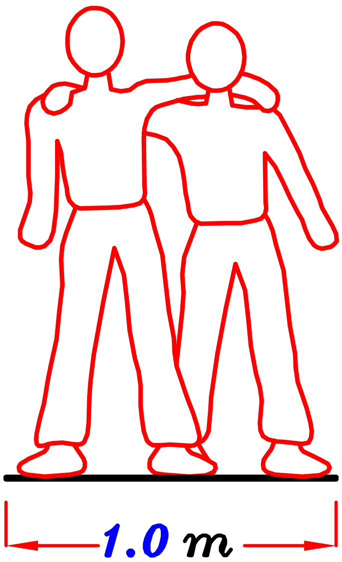
Inclined Slabs. البلاطات المائله

هناك نقطتان أساسيتان يجب أن تؤخذا فى الإعتبار مع البلاطات المائله :

١ـ جميع الأحمال تؤخذ على الطول المائل.

ماعدا الحمل الحى *L.L.* يؤخذ على الطول الأفقى .

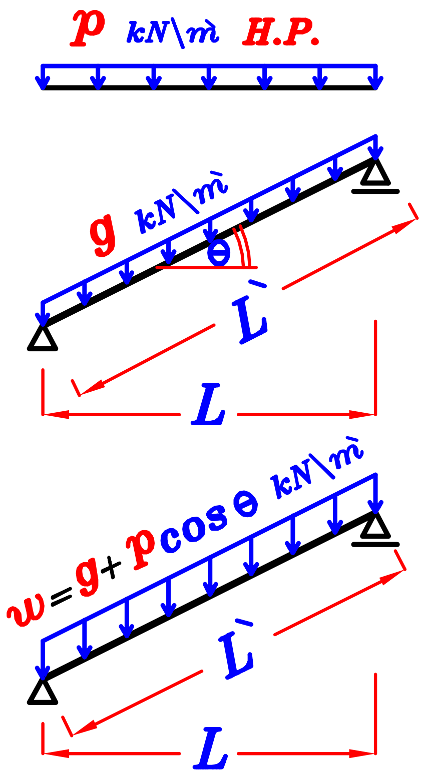




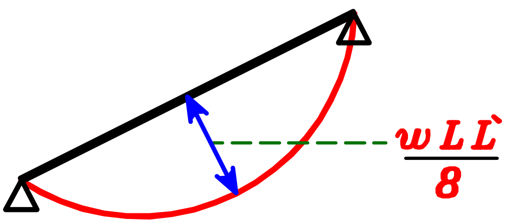
***H.P.* *Horizontal Projection* المسقط الأفقى**

عدد الأشخاص الذين يستطيعوا أن يقفوا على ١,٠ م أفقى فقط

هو نفس عدد الأشخاص الذين يستطيعوا أن يقفوا على ١,٣٠ م مائل.

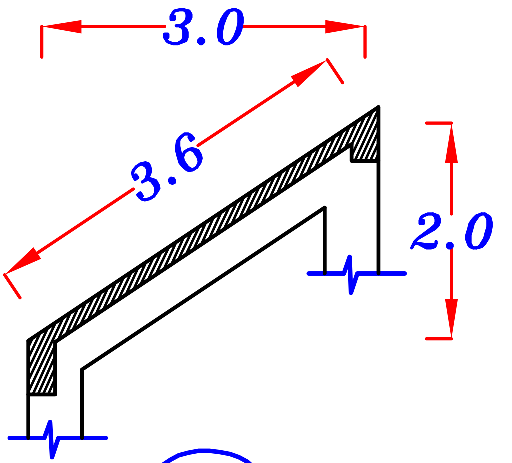


B.M.D.

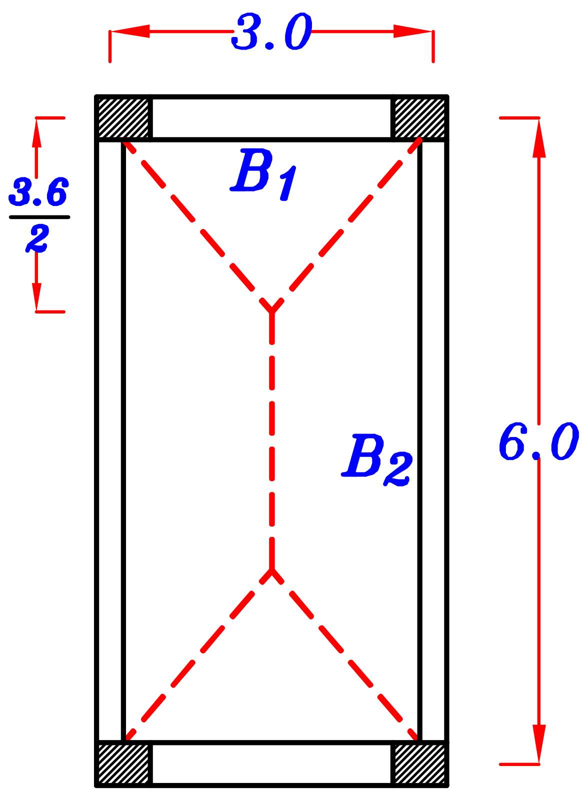


٢- عند توزيع الأحمال فى البلاطات المائله
يجب أن نأخذ الأطوال الحقيقيه و ليس المساقط .

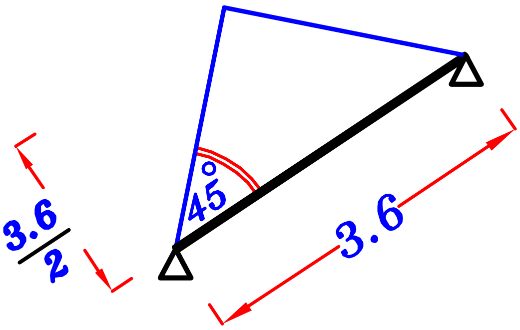
Example.



الطول الحقيقى 3.60



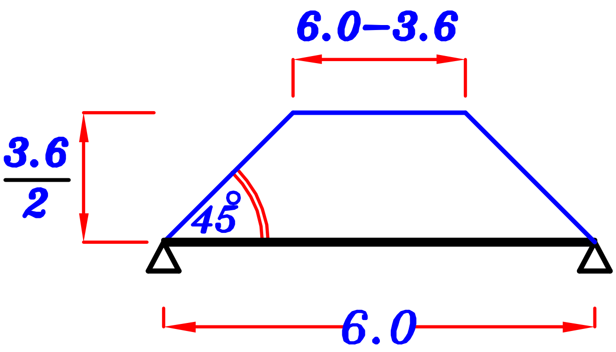
B_1



$$w_{si} = t_s \gamma_c + F.C. + L.L. \cos\theta = \checkmark\ kN\backslash m^2$$

$$w = O.W. + walls + C_a\, w_{si} \left(\frac{3.6}{2}\right) = \checkmark\ kN\backslash m'$$

B_2



$$C_a = 1 - \frac{1}{2}\left(\frac{3.6}{6.0}\right)$$

$$C_e = 1 - \frac{1}{3}\left(\frac{3.6}{6.0}\right)^2$$

$$w_{si} = t_s \gamma_c + F.C. + L.L. \cos\theta = \checkmark\ kN\backslash m^2$$

$$w = O.W. + walls + C_a\, w_{si} \left(\frac{3.6}{2}\right) = \checkmark\ kN\backslash m'$$

Max–Max B.M.D.
For Inclined Slabs

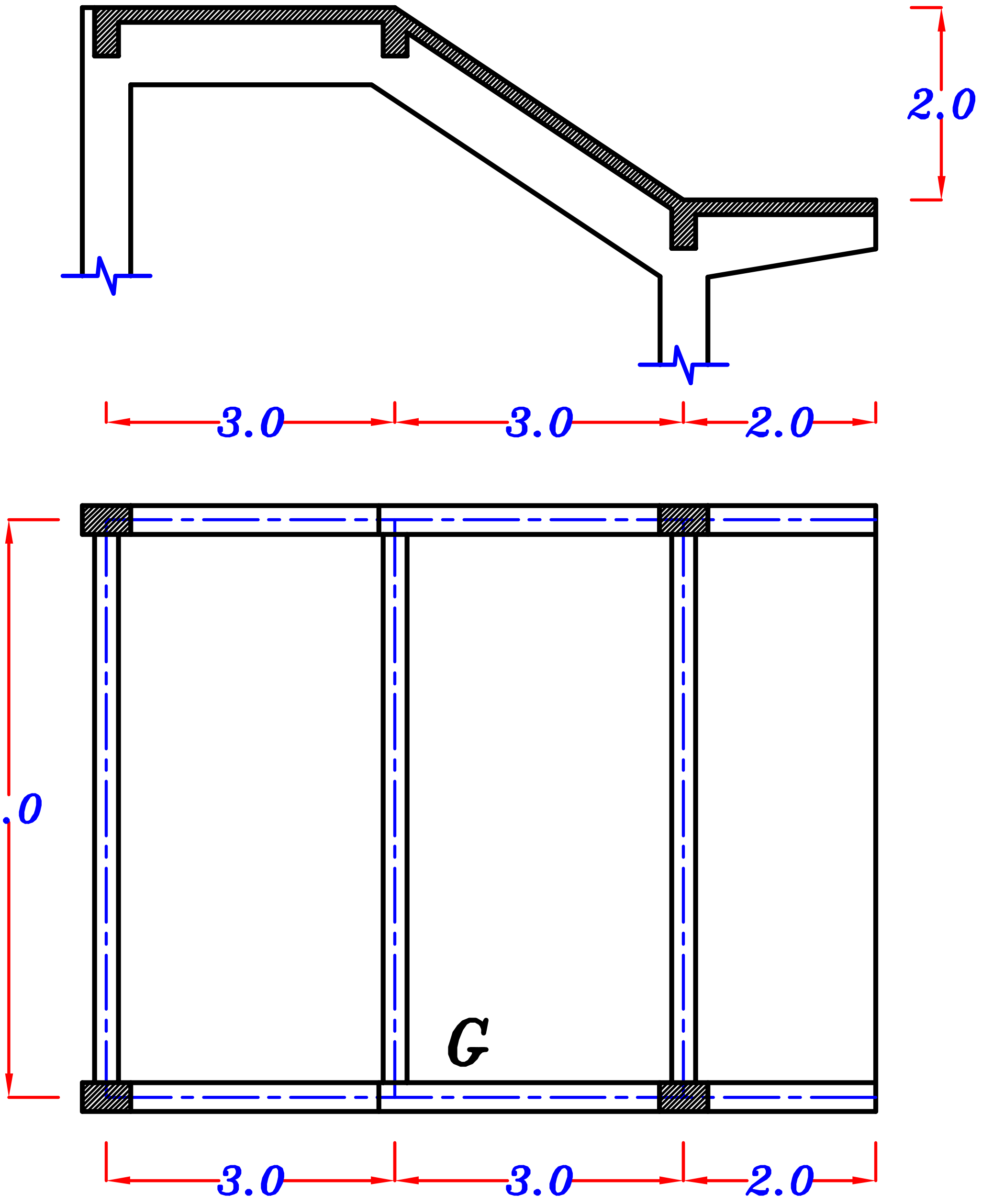
Load of the Slab.

$$\boxed{g_s = t_s * \gamma_c + F.C.}$$ For Horizontal & Inclined Slabs

$$\boxed{p_{sh} = L.L.}$$ For Horizontal Slabs

$$\boxed{p_{si} = L.L. \cos\theta}$$ For Inclined Slabs

Example.



Data.

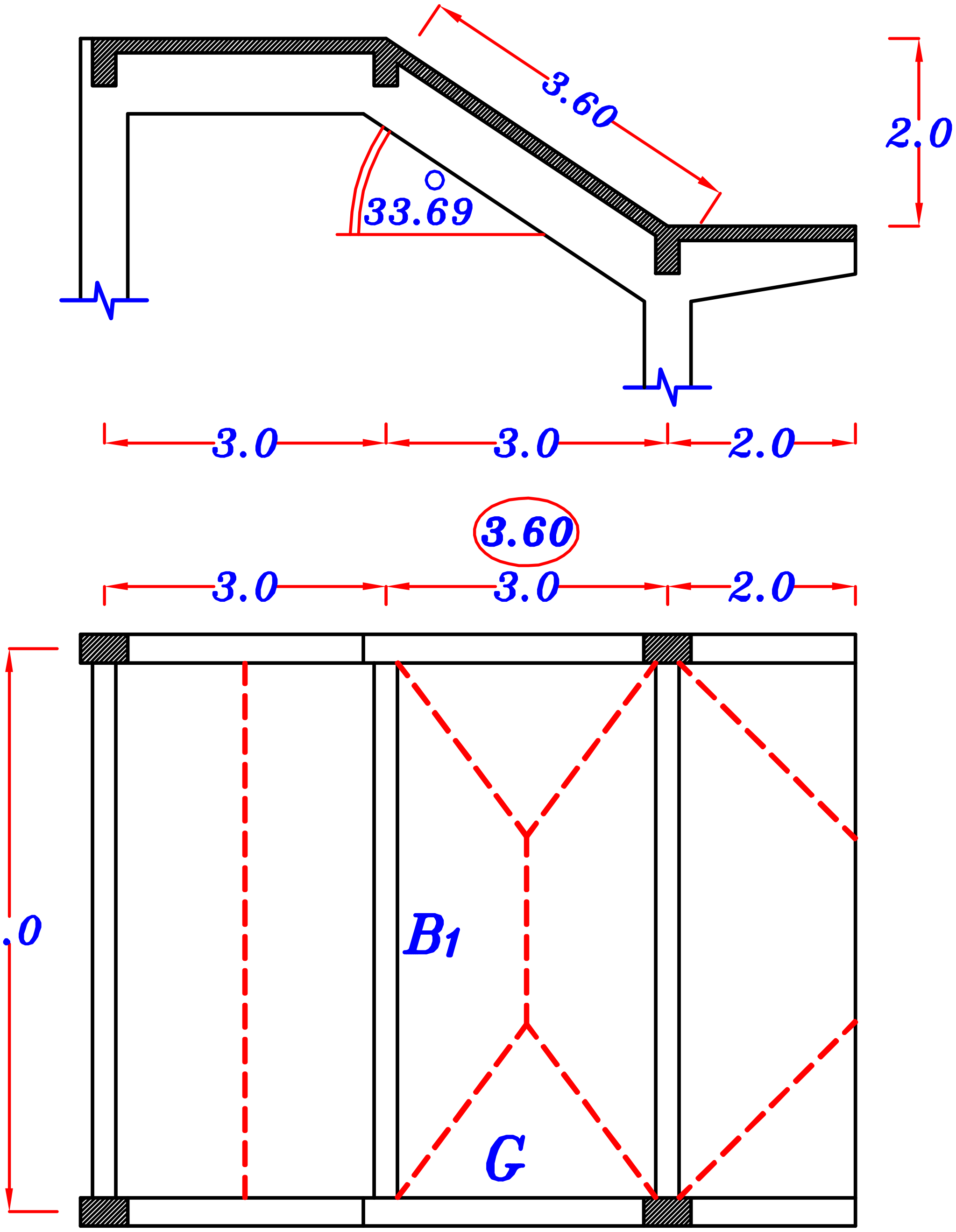
$t_s = 0.12\ m$, $F.C. = 1.50\ kN\backslash m^2$, $L.L. = 2.0\ kN\backslash m^2$

$O.W.$ of Beam $= 3.0\ kN\backslash m`$ , $O.W.$ of Girder $= 5.0\ kN\backslash m`$

Req.

1- Draw max.-max. B.M.D. For the Girder.

2- Draw S.F.D. & N.F.D. Case of total load only.



g_s , p_s

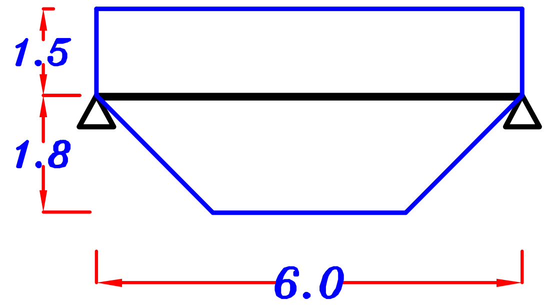
$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 2.0 \ kN\backslash m^2 \text{ ----- HL. Slab.}$$

$$p_{si} = L.L. * Cos\,\theta = 2.0 * Cos\,33.69^\circ = 1.66 \ kN\backslash m^2 \text{ --- Inclined Slab.}$$

$$\boxed{g_s = 4.50 \ kN\backslash m^2} \ , \ \boxed{p_{sh} = 2.0 \ kN\backslash m^2} \ , \ \boxed{p_{si} = 1.66 \ kN\backslash m^2}$$

B_1



For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.6}{6.0}\right) = 0.70$$

$$g_a = O.W. + \quad g_s \frac{L_s}{2} \quad + C_a \, g_s \frac{L_s}{2}$$

$$= 3.0 + (4.50)\left(\frac{3}{2}\right) + (0.70)\,(4.50)\left(\frac{3.60}{2}\right) = 15.42 \ kN\backslash m`$$

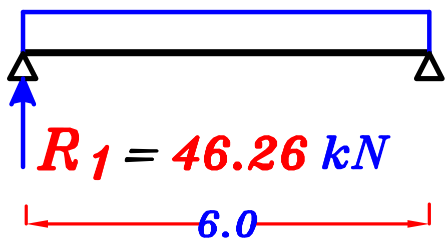
$$p_a = \ p_{sh} \frac{L_s}{2} \quad + \quad C_a \, p_{si} \frac{L_s}{2}$$

$$= (2.0)\left(\frac{3}{2}\right) + (0.70)\,(1.66)\left(\frac{3.60}{2}\right) = 5.09 \quad kN\backslash m`$$

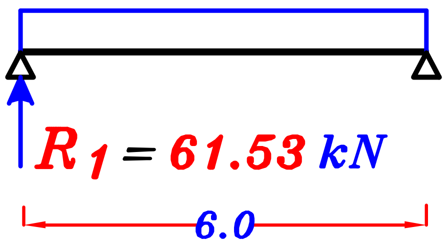
$$w_a = g_a + p_a = 15.42 + 5.09 = 20.51 \ kN\backslash m`$$

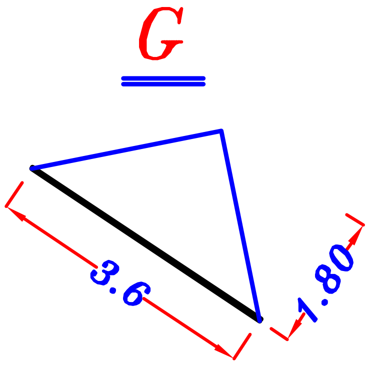
$$\boxed{\begin{aligned} R_1 &= 46.26 \ kN \ \text{---} \ D.L. \\ &= 61.53 \ kN \ \text{---} \ T.L. \end{aligned}}$$

$g_a = 15.42 \ kN\backslash m`$

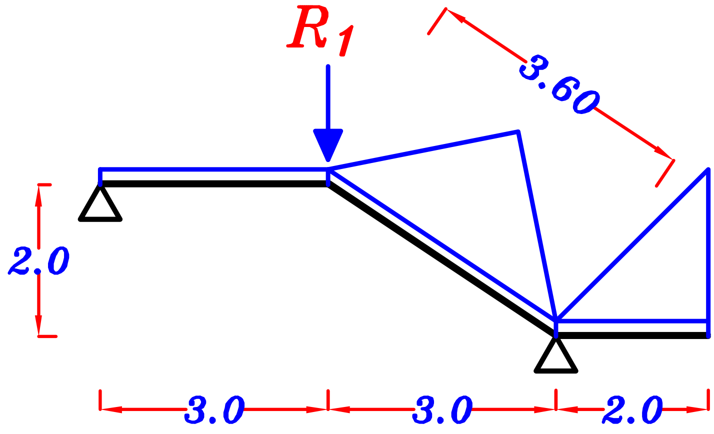


$w_a = 20.51 \ kN\backslash m`$



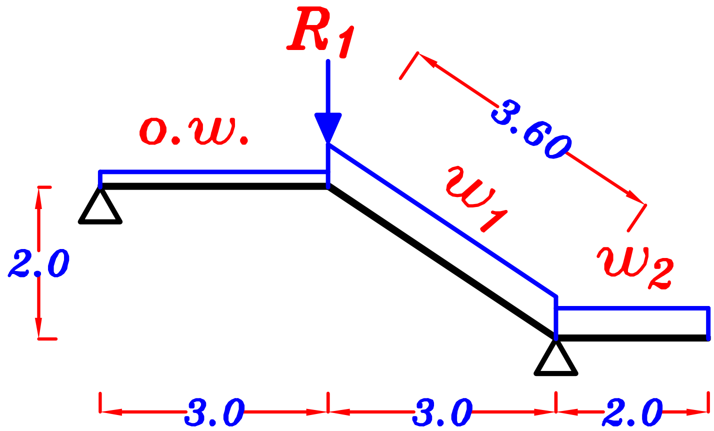


$area = 3.24\ m^2$



For Triangle

$C_a = \frac{1}{2}\ ,\ C_e = \frac{2}{3}$



w_1

Load For Shear = Load For Moment

$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 5.0 + \left(\frac{3.24}{3.60}\right)(4.50) = 9.05\ kN\backslash m'$$

$$p_1 = \frac{\sum area}{span} * p_{si} = \left(\frac{3.24}{3.60}\right)(1.66) = 1.49\ kN\backslash m'$$

$$w_1 = g_1 + p_1 = 9.05 + 1.49 = 10.54\ kN\backslash m'$$

w_2

Load For shear.

$$g_a = O.W. + C_a\ g_s\ L_c = 5.0 + \frac{1}{2}(4.50)(2.0) = 9.50\ kN\backslash m$$

$$p_a = C_a\ p_{sh}\ L_c = \frac{1}{2}(2.0)(2.0) = 2.0\ kN\backslash m$$

$$w_a = g_a + p_a = 9.50 + 2.0 = 11.50\ kN\backslash m'$$

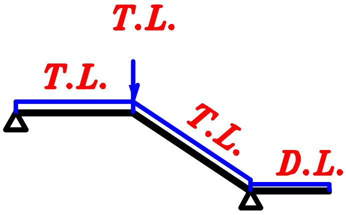
Load For Moment.

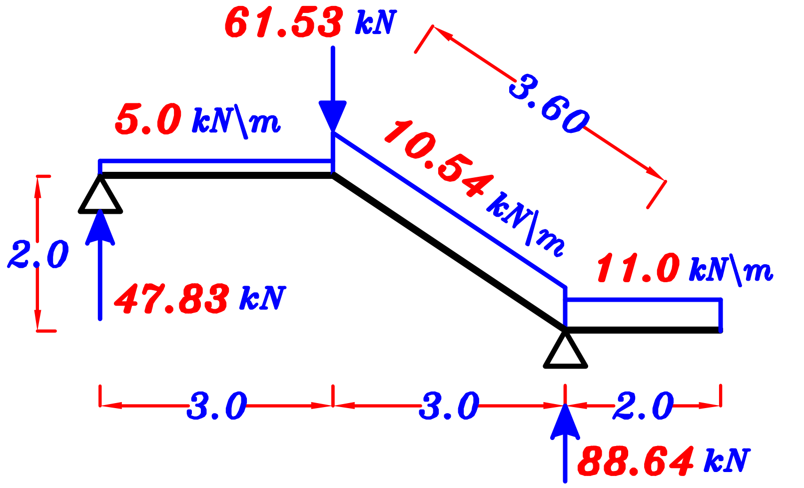
$$g_e = O.W. + C_e\ g_s\ L_c = 5.0 + \frac{2}{3}(4.50)(2.0) = 11.0\ kN\backslash m$$

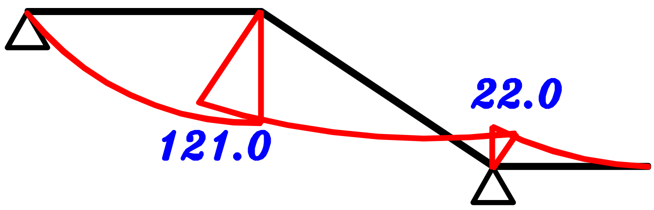
$$p_e = C_e\ p_{sh}\ L_c = \frac{2}{3}(2.0)(2.0) = 2.67\ kN\backslash m$$

$$w_e = g_e + p_e = 11.0 + 2.67 = 13.67\ kN\backslash m'$$

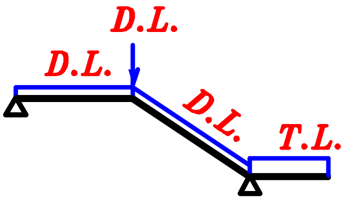
1- max. +ve B.M.D.

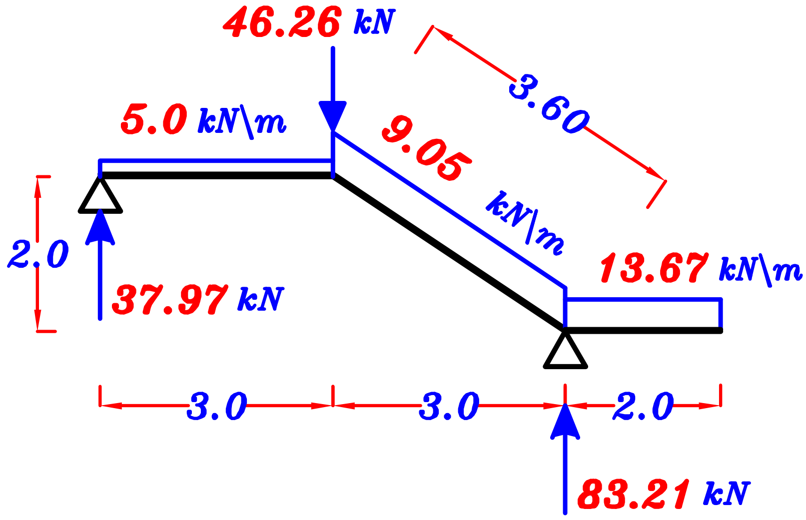


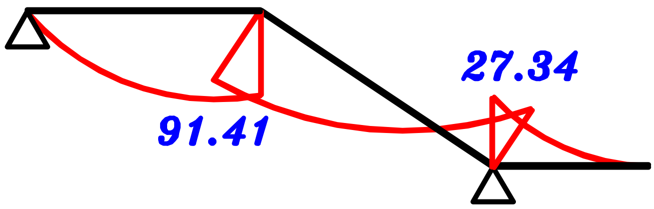




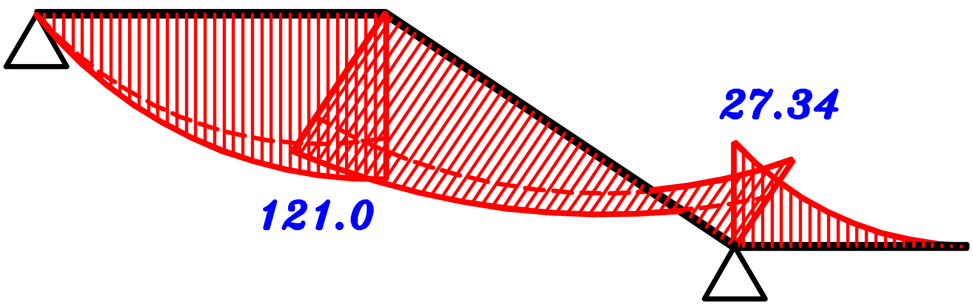
2- max. −ve B.M.D.



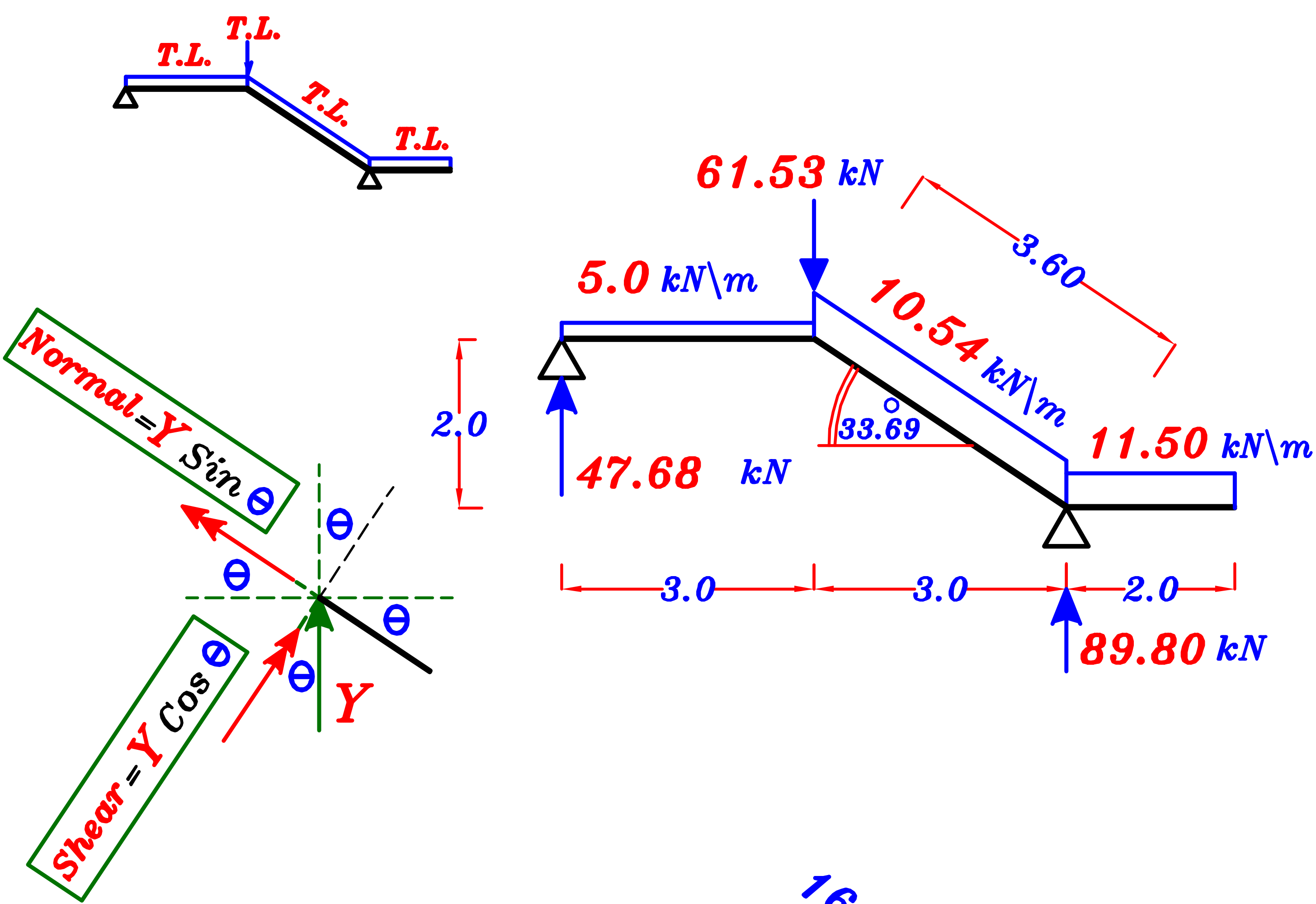




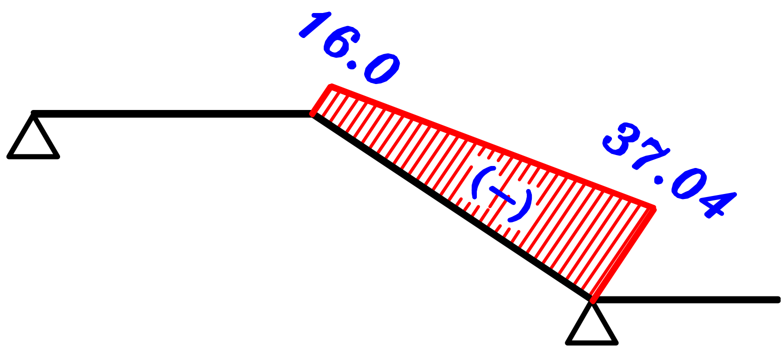
max−max B.M.D. For the Girder.



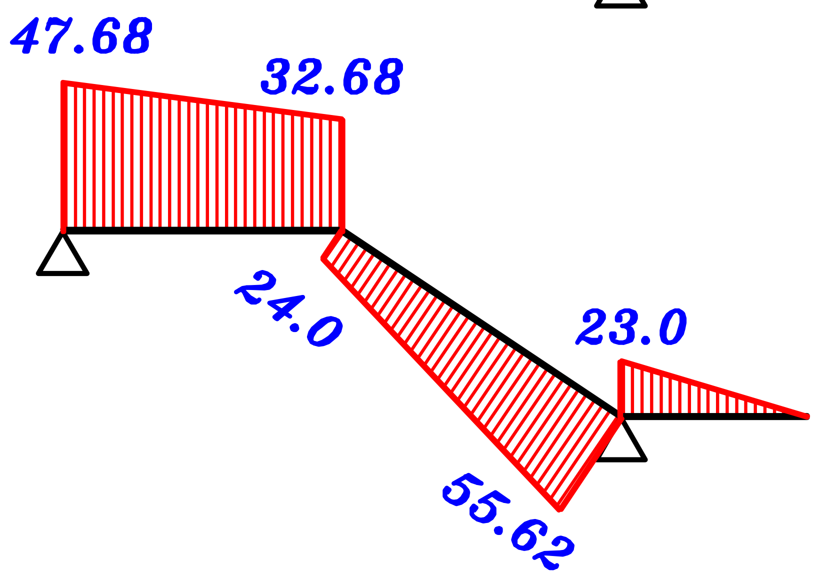
N.F.D. & S.F.D. For the Girder (G)



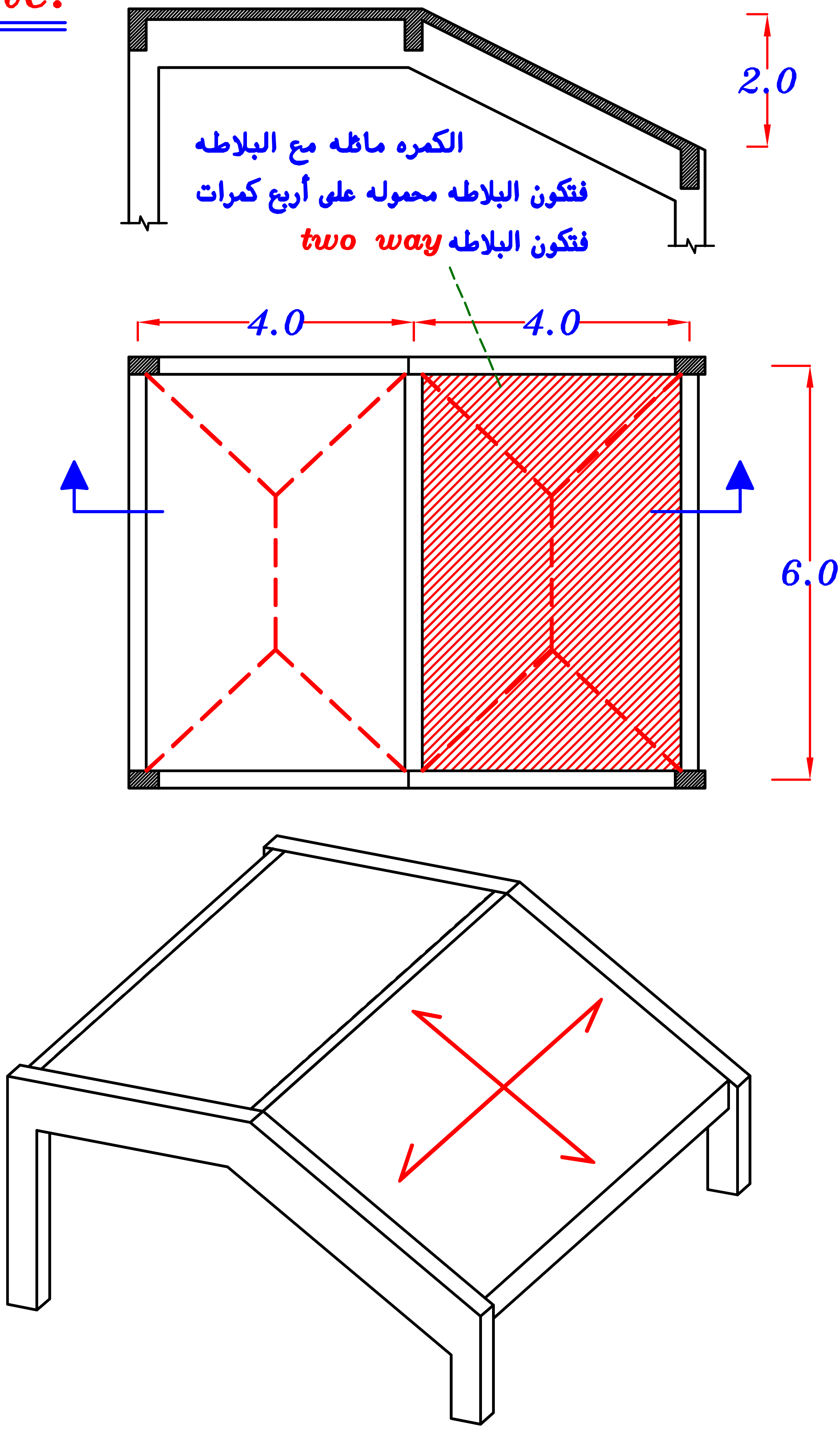
N.F.D.



S.F.D.

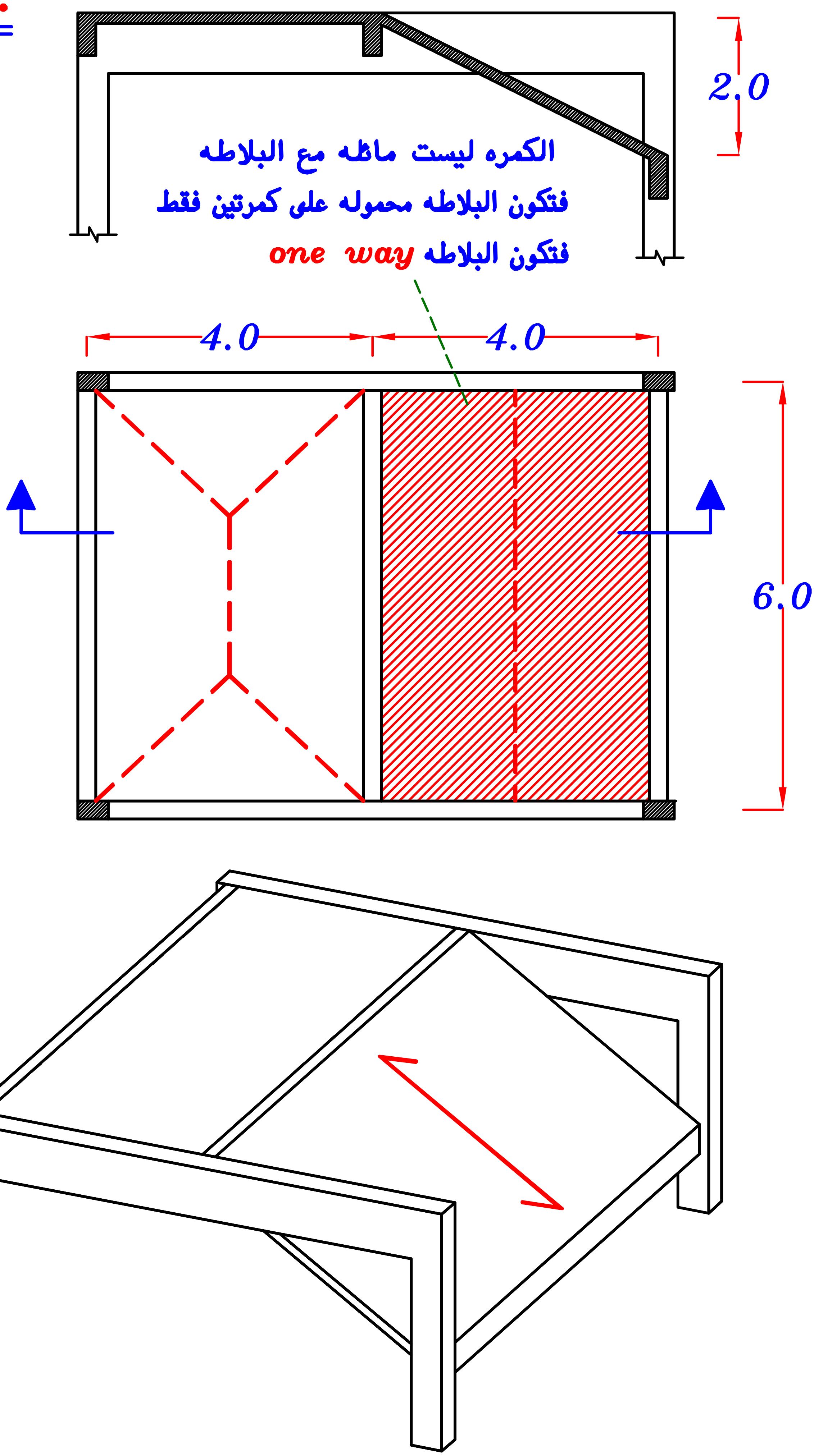


Note.

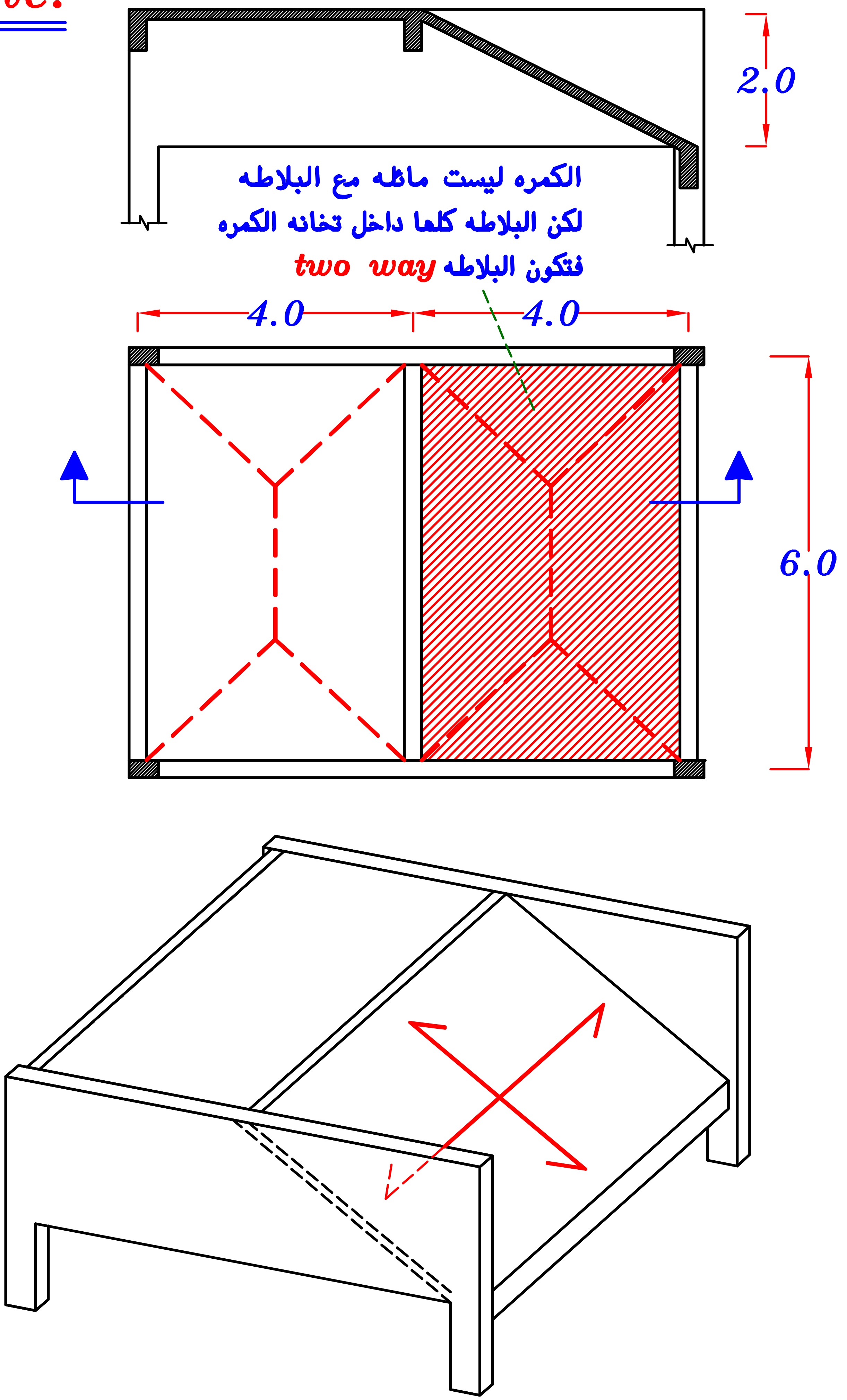


2.0
الكمره مائله مع البلاطه
فتكون البلاطه محموله على أربع كمرات
فتكون البلاطه two way
4.0
4.0
6.0

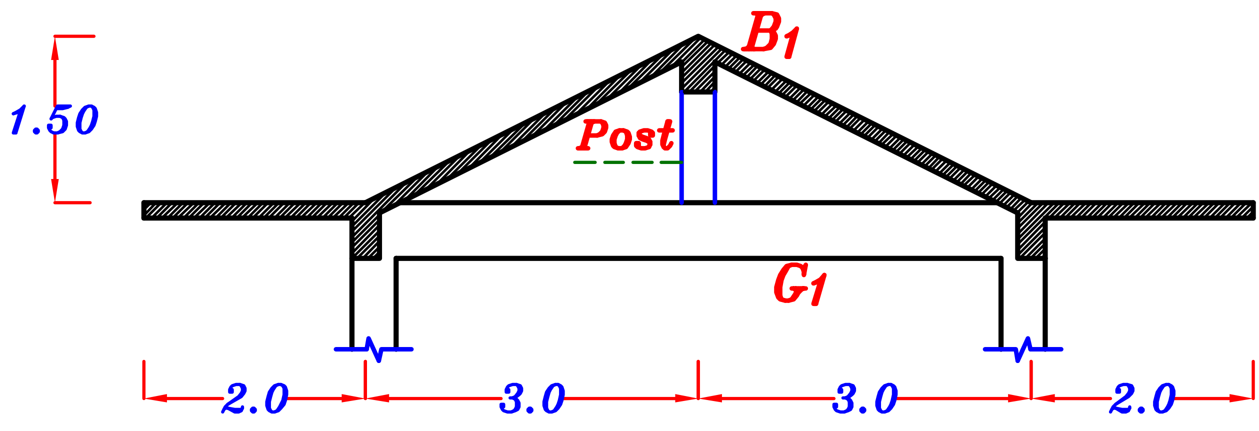
Note.


2.0
الكمره ليست مائله مع البلاطه
فتكون البلاطه محموله على كمرتين فقط
فتكون البلاطه one way
4.0
4.0
6.0

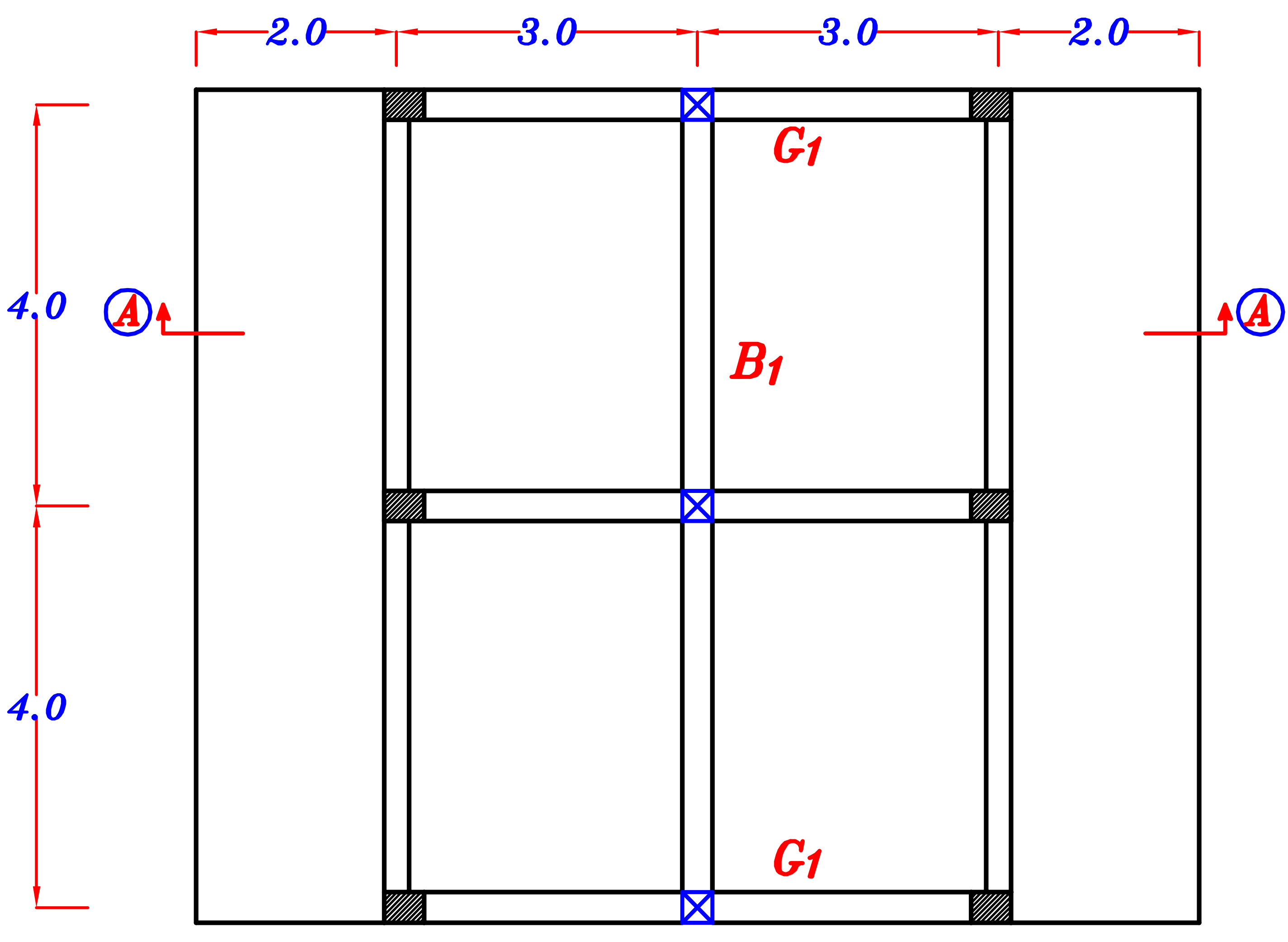
Note.


2.0
الكمره ليست ماثله مع البلاطه
لكن البلاطه كلها داخل تخانه الكمره
فتكون البلاطه two way
4.0
4.0
6.0

Note.



Sec. (A–A)

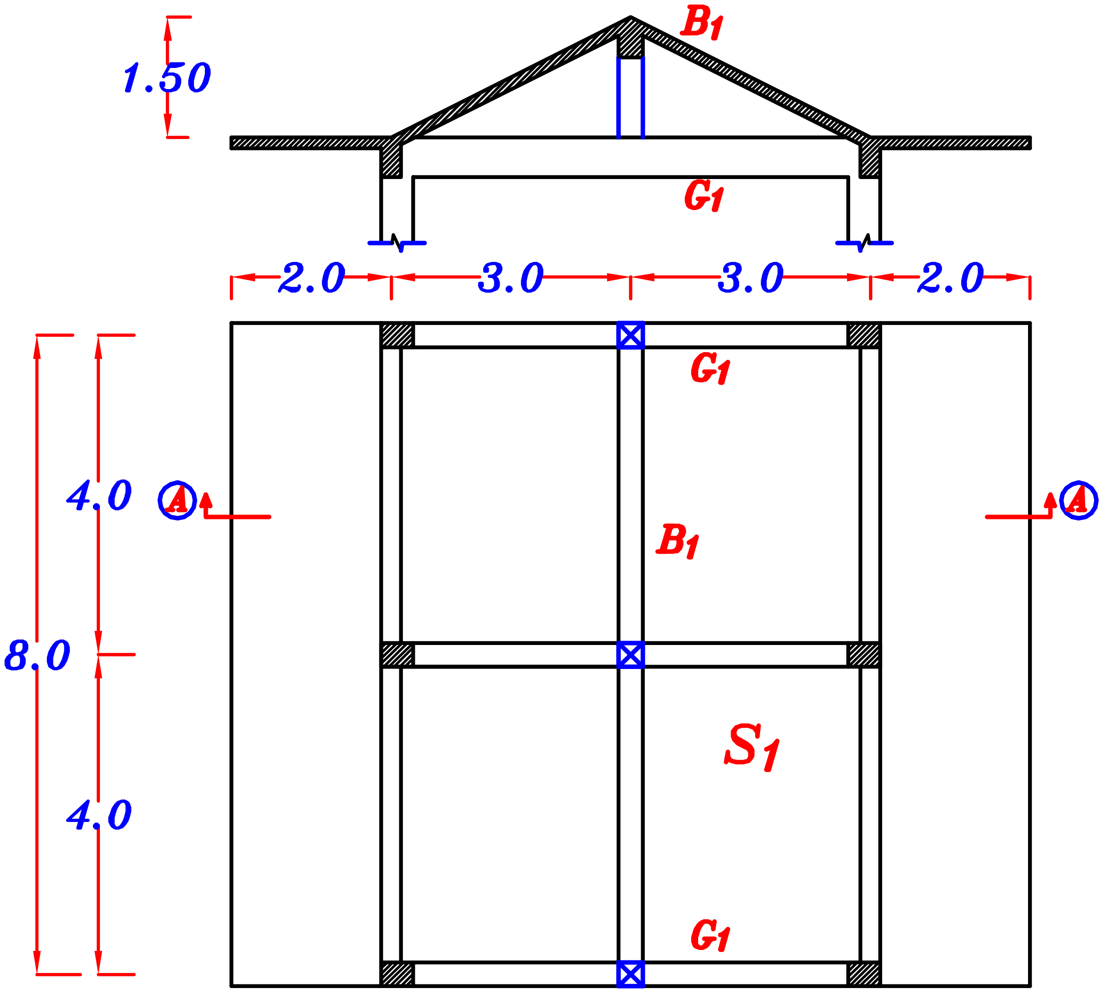


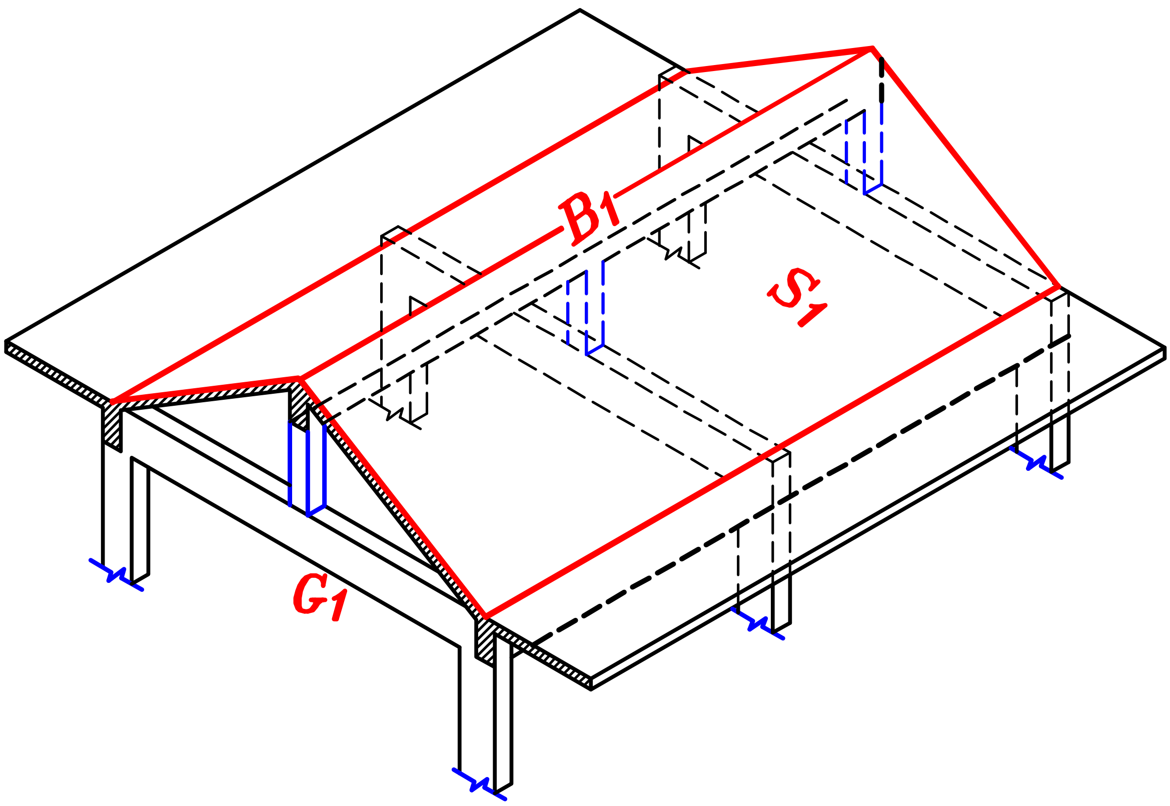
Plan

كما هو ظاهر من ال Cross Section

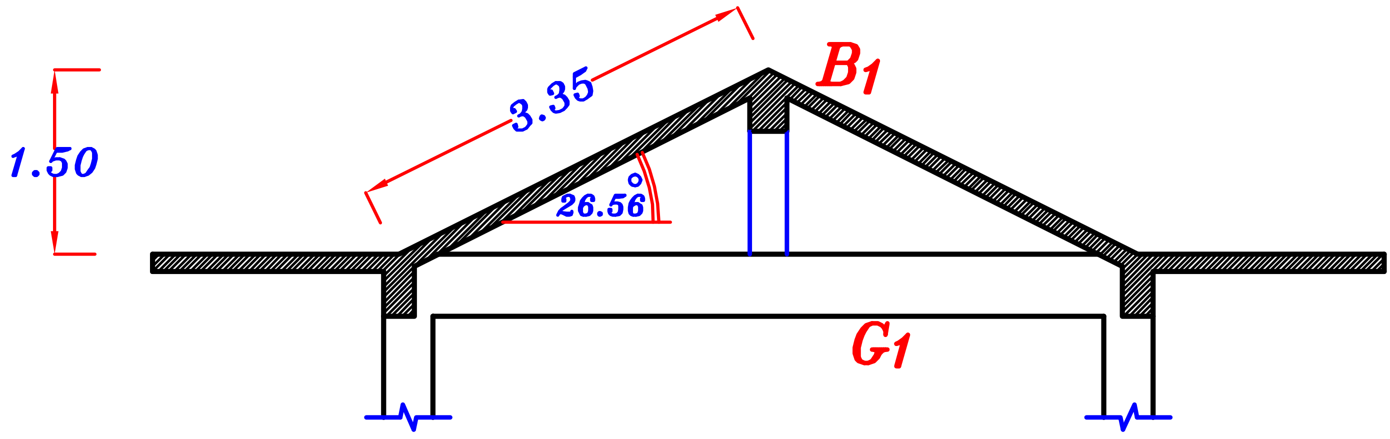
أن البلاطه المائله محموله على كمرتين فقط و ليست محموله على ال Girders

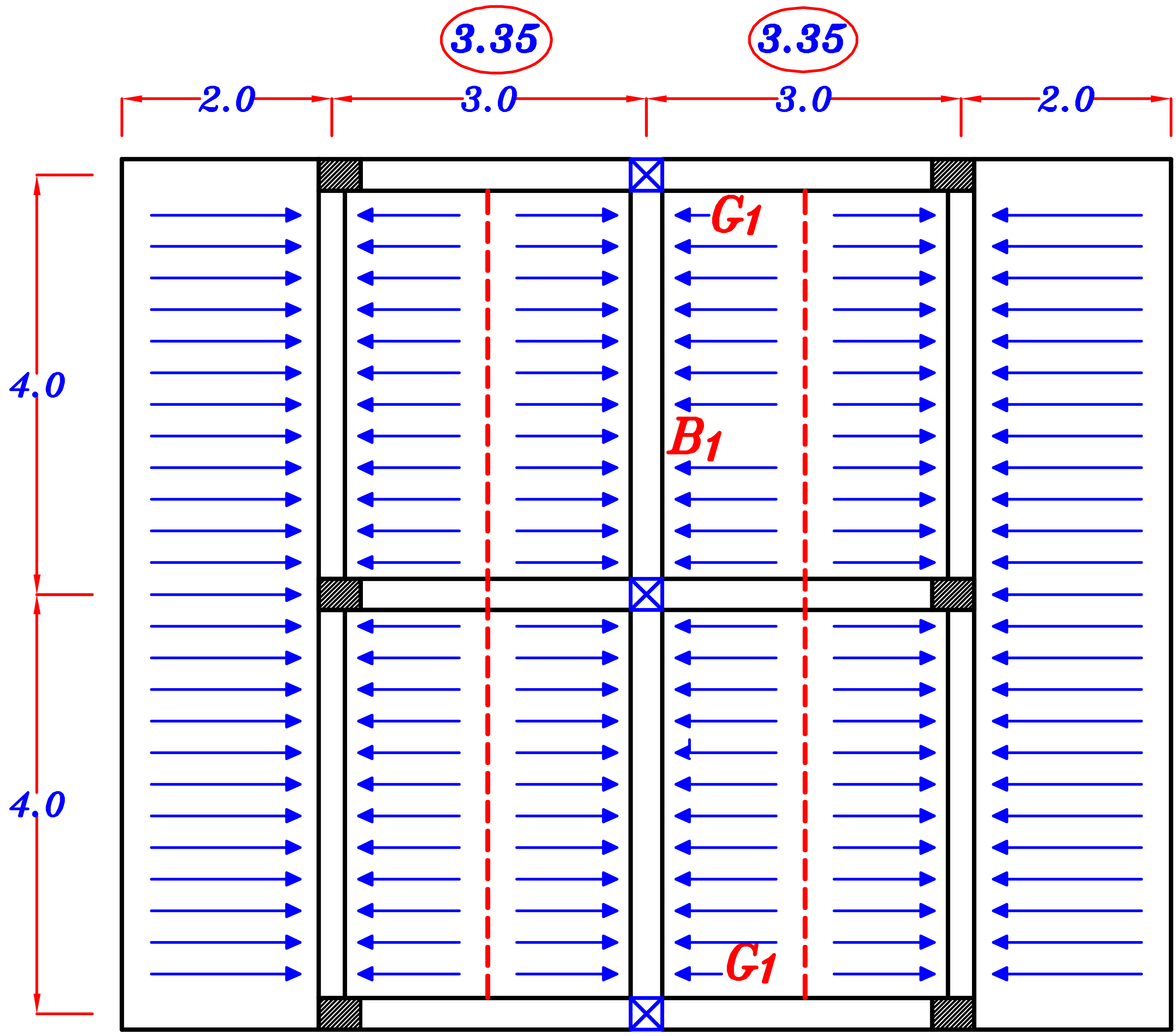
لذا فالبلاطه المائله تعتبر بلاطه One way





البلاطه S_1 محموله على كمرتين فقط و بالتالى فهى بلاطه **one way**

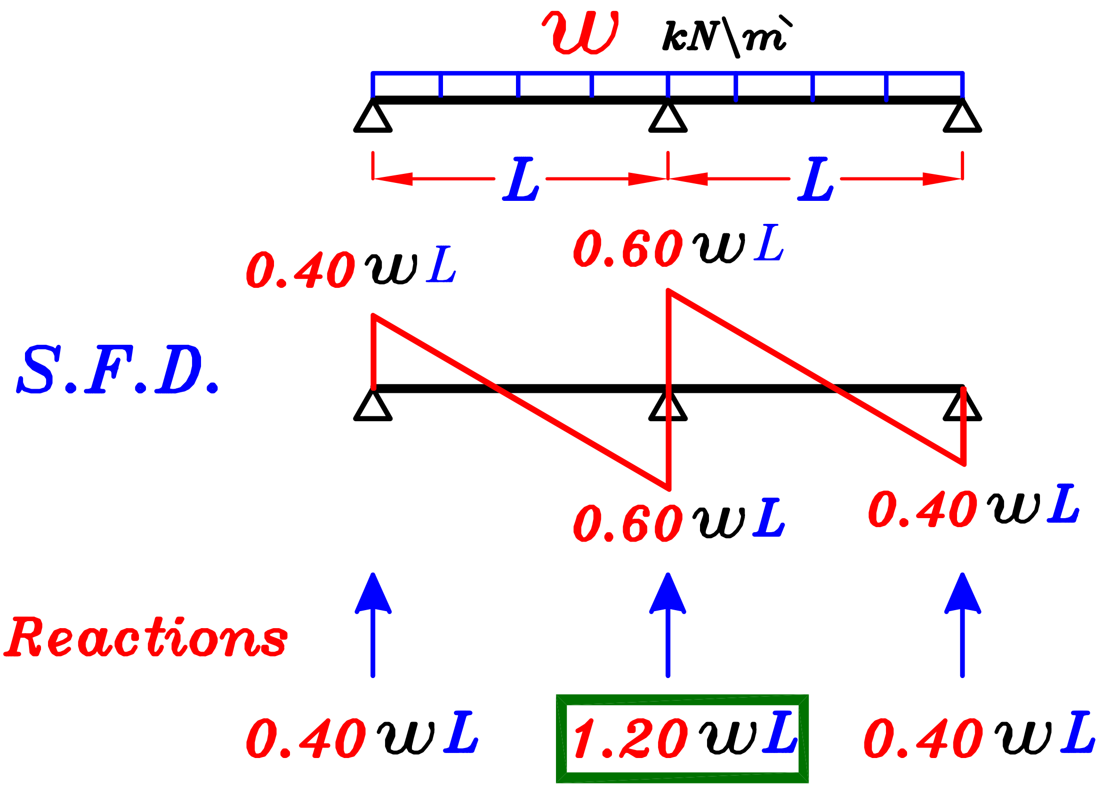

3.35
B1
1.50
26.56°
G1


3.35
3.35
2.0
3.0
3.0
2.0
4.0
4.0
G1
B1
G1

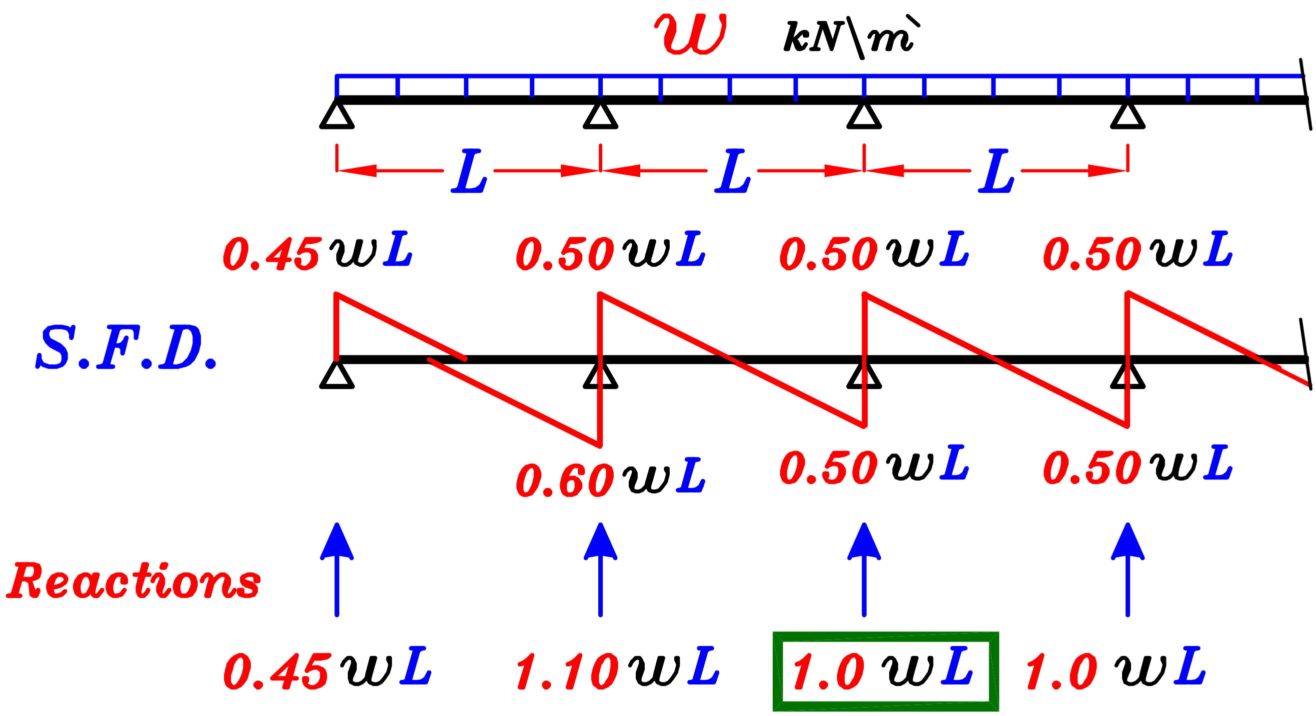
Reactions of Continuos Beams

لحساب Reactions الكمرات الـ Continuos سنحتاج لحلها بطريقه من طرق حل الـ indetermonate structures
لكن اذا كانت البحور متساويه (equal spans) و الاحمال متساويه (equal loads) فمن الممكن استخدام القيم التاليه

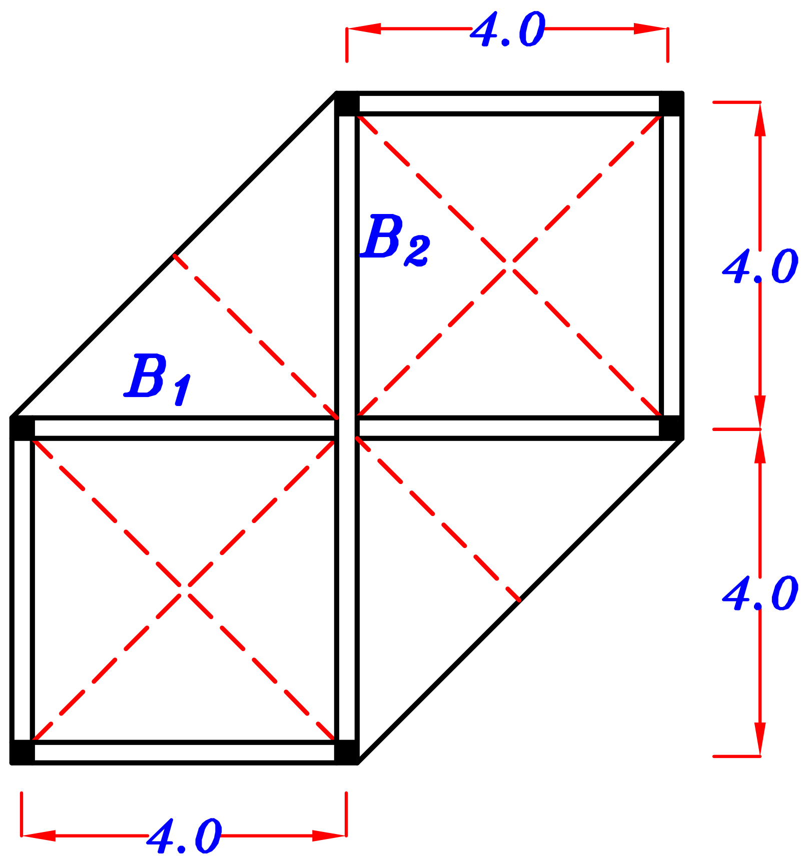
① Continuos Beam with 2 spans.



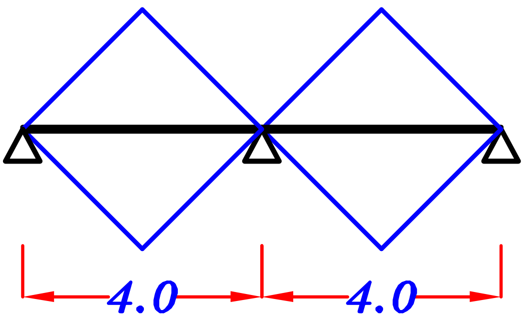
② Continuos Beam with more than 2 spans.

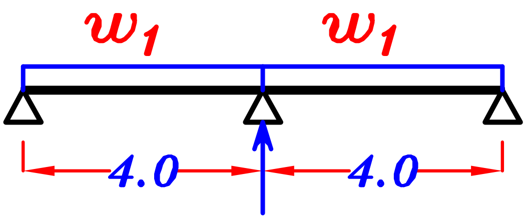


Example.



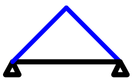
B_1





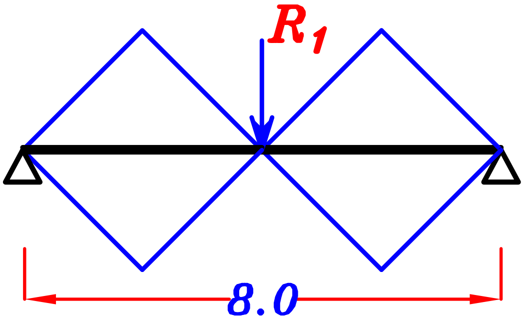
$R_1 = 1.2\ w_1\ L$

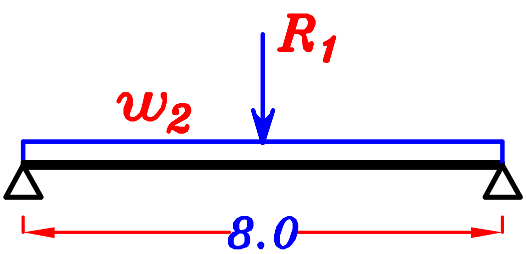
$1.2\ w_1\ (4.0)$



$$w_1 = O.W. + 2.0 \left[\frac{C_a}{C_e}\ w_s\ \frac{L_s}{2} \right]$$

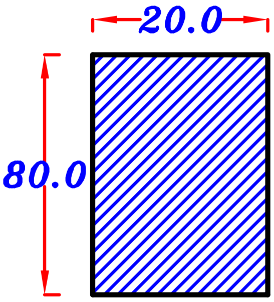
B_2





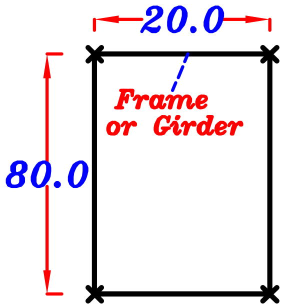
$$w_2 = O.W. + \frac{\sum area}{Span} * w_s = O.W. + \frac{(4*0.5*4*2)}{(8.0)} * w_s$$

Sectional Elvation مسائل ال

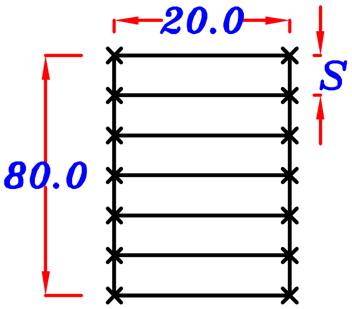


لعمل تغطيه (سقف) للمساحات الكبيره مثل المصانع بدون وضع أعمده داخليه .

يتم عمل الاتى :

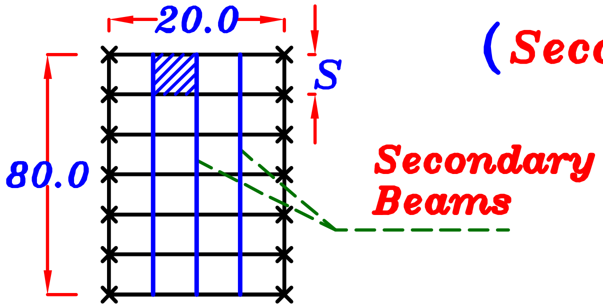


١- يتم وضع **Frame** أو **Girder** (كمره كبيره)
فى الاتجاه القصير للارض .



٢- يتكرر كل مسافه تسمى *Spacing*

Spacing (S) ≃ (4.0 → 8.0 m)

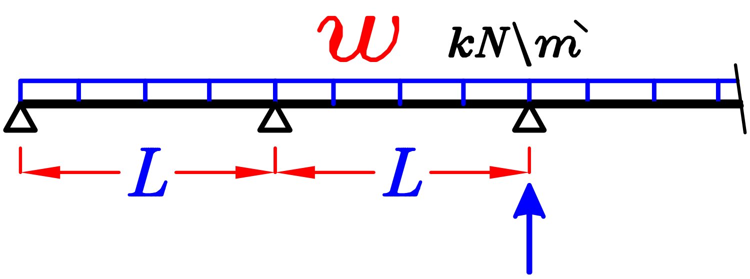


٣- نضع كمرات ثانويه **(Secondary Beams)**
محموله على ال **Girder**
و ذلك لتقليل مساحات البلاطات

٤- لان الكمرات الثانويه محموله على ال **Girder**
فيجب حساب ال **Reactions** لها أولا

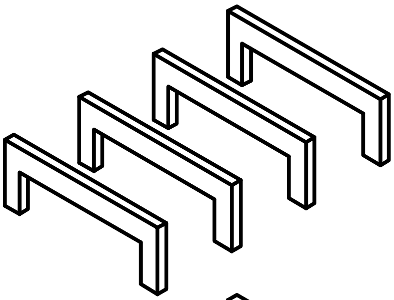
و لان الكمرات الثانويه تعتبر كمرات *Continuos Beams with more than 2 spans*

فيكون ال **Reaction** لها
يساوى $\boxed{w * S}$

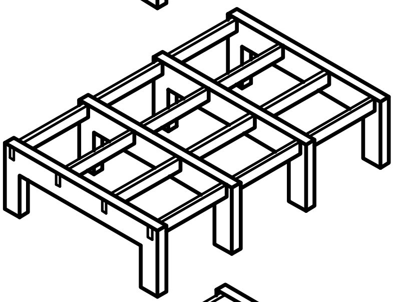


$$\boxed{1.0\, wL = w * S}$$

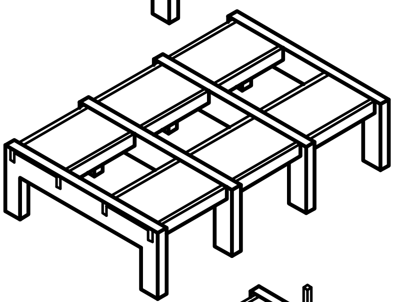
Sky Light الشخشيخه



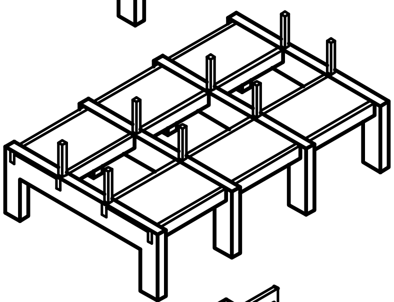
١- يتم تكرار الـ Girder كل Spacing

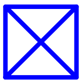


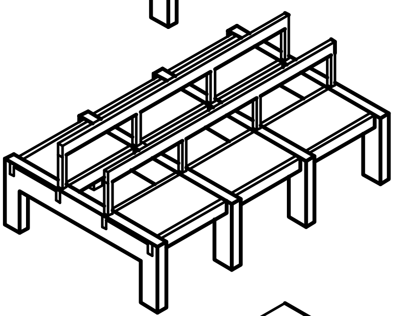
٢- يتم وضع الكمرات الثانويه
محموله على الـ Girder



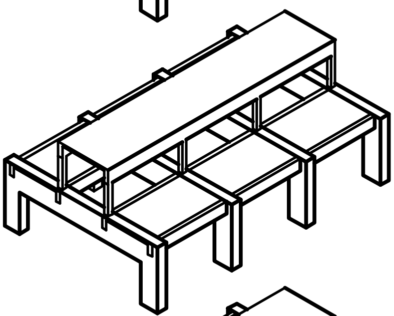
٣- توضع البلاطات محموله على الـ Girder
و الكمرات الثانويه



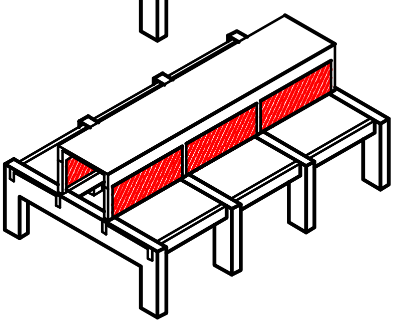
٤- يتم وضع أعمده قصيره تسمى (شمعه) Post
و يكون شكله فى Cross section 



٥- توضع كمرات ثانويه محموله على الـ Posts



٦- توضع بلاطه محموله على الكمرات الثانويه العلويه



٧- توضع الشبابيك بين الـ Posts

ما الفارق بين الـ Frame و الـ Girder ؟؟

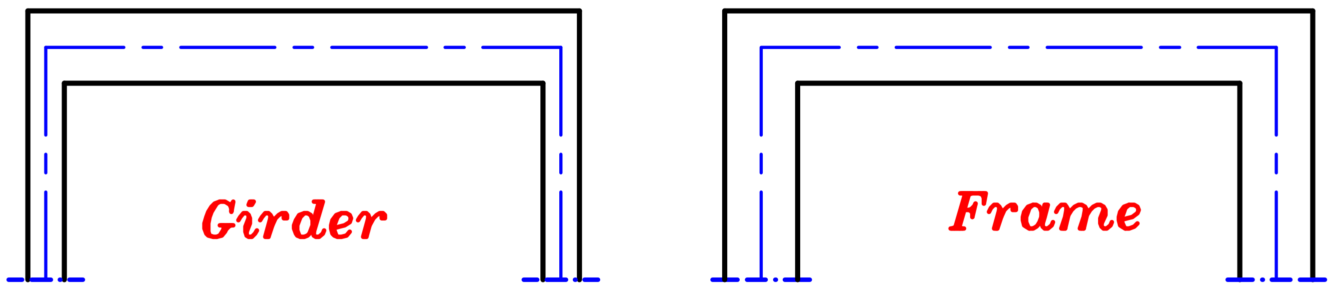
كلاً من الـ Frame و الـ Girder عباره عن كمره محموله على عمودين

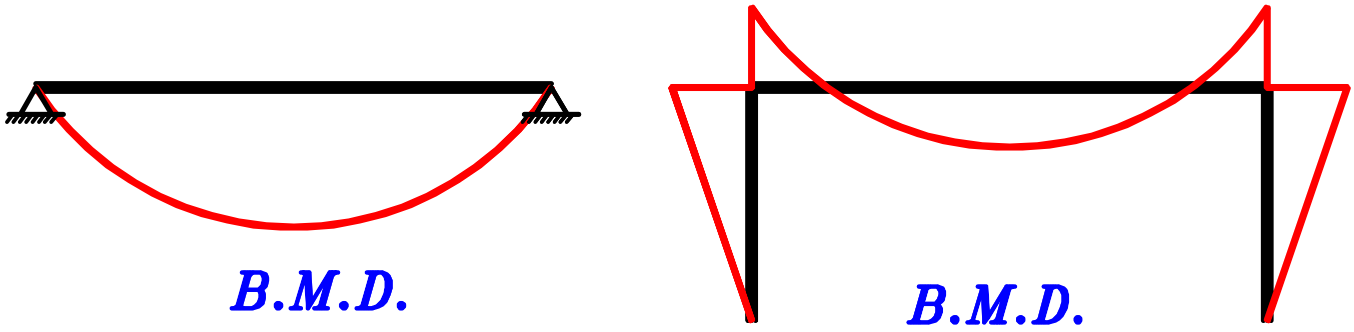
لكن الفرق بينهم أن فى الـ Frame الاعمده سميكه أى ان الـ stiffness للاعمده قريب من الكمرات

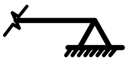
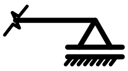
و تفصيله الحديد بينهم تعمل على نقل العزوم من الكمره للعمود Rigid joint

أما الـ Girder فأعمدته نحيفه نسبيا أى أن الـ stiffness للاعمده أقل كثير من الكمرات

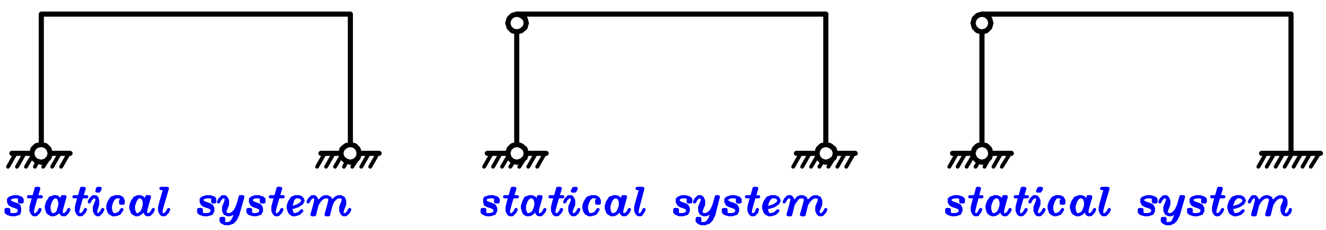
و تفصيله الحديد بينهم لا تعمل على نقل العزوم من الكمره للعمود Hinged joint





فى الـ Girder نهمل الاعمده و نضع بدلا منها support  أو 

أما فى الـ Frame فيجب اعطائنا الـ statical system فى المسأله



ملحوظه

ممكن اهمال الـ Reaction الكمرات الثانويه الموجوده فوق الاعمده مباشره فى الـ Girder

و لكن يجب أخذها فى الاعتبار مع الـ Frame لرسم الـ N.F.D. على الاعمده

خطوات مسأله ال *cross-section* (*Total Load*)

١- نستنتج ال *Plan*

٢- نرسم خطوط توزيع ال *Loads* (*Load Distribution*)

٣- نسمى الكمرات ...... B_1 , B_2 , B_3

٤- نحسب w_s

٥- نحسب *Load For Shear* للكمرات الثانويه و نحدد ال *Reactions*.

$$\boxed{R = w * S}$$

٦- نضع الاحمال على ال *Girder* **بالترتيب التالى :-**

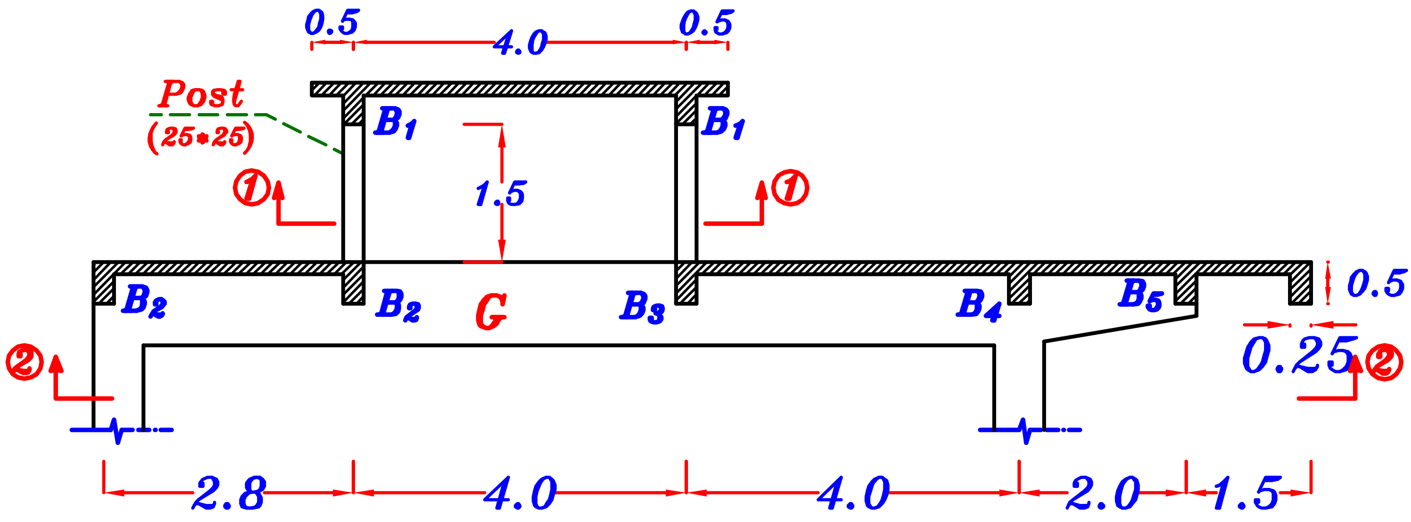
أ - نضع *o.w.* على ال *Girder* كله .

ب - نضع *Reactions* الكمرات الثانويه *concentrated loads* على ال*Girder*

ج - نضع أحمال البلاطه التى تنتقل مباشره من البلاطه الى ال *Girder* .
و تظهر هذه الاحمال من ال *plan*.

٧- نرسم *B.M.D. & S.F.D.* للـ*Girder*

Example.



$t_s = 120$ mm

F.C. = 1.50 kN\m², L.L. = 2.0 kN\m²

O.W. of beams = 3.0 kN\m', O.W. of Girder = 6.0 kN\m'

Spacing = 6.0 m

Req. Draw S.F.D. & B.M.D. For the girder (G).

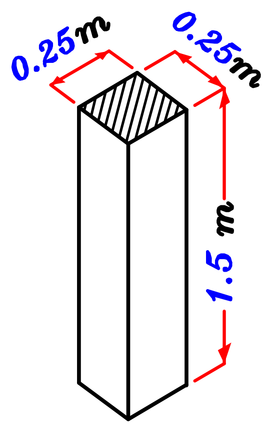
Case of Total Load is only required.

$$w_s = t_s * \gamma_c + F.C. + L.L.$$

$$= 0.12 * 25 + 1.50 + 2.0 = 6.50 \ kN\backslash m^2$$

$$\boxed{w_s = 6.50 \ kN\backslash m^2}$$

Post

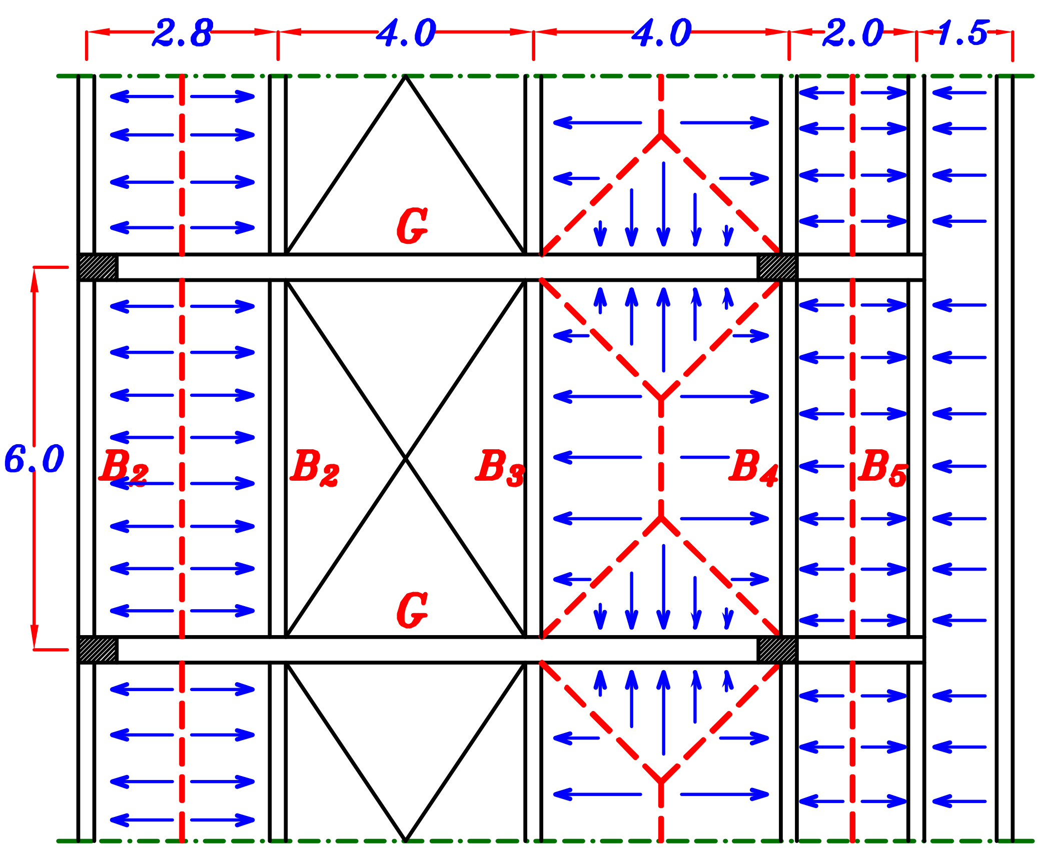


Weight of the Post = Volume * Density

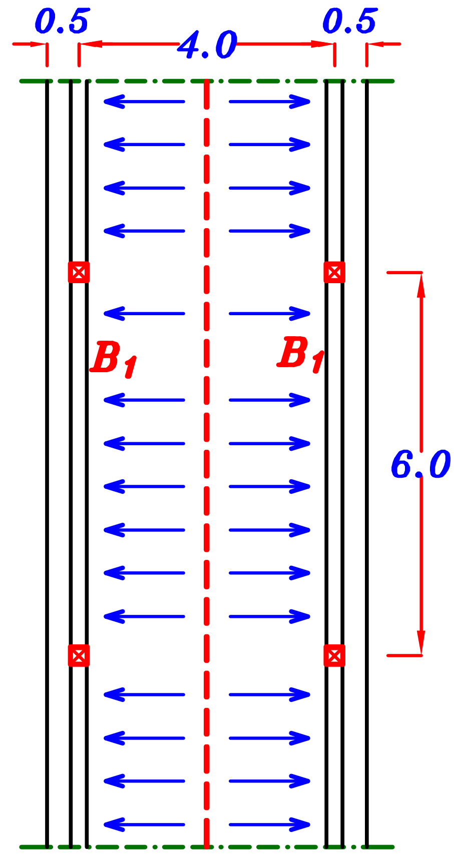
$$= (0.25 * 0.25 * 1.50)(25) = 2.34 \ kN$$

$$\boxed{\text{Weight of the Post} = 2.34 \ kN}$$

Note : Weight of Post can be neglected.

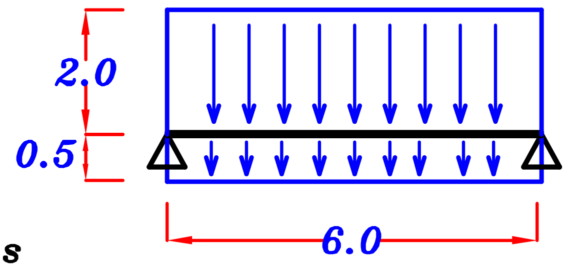


Plan (2–2)



Plan (1–1)

B_1



Load For Shear = Load For moment

$$w_a = w_e = O.W. + w_s L_c + w_s \frac{L_s}{2}$$

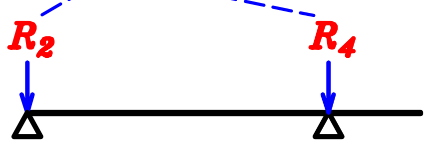
$$= 3.0 + (6.50)(0.5) + (6.50)\left(\frac{4}{2}\right) = 19.25 \ kN\backslash m'$$

$$R_1 = w_a * Spacing = 19.25 * 6.0 = 115.5 \ kN$$

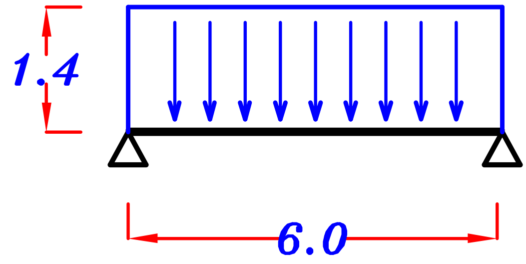
$$\boxed{R_1 = 115.5 \ kN}$$

ملحوظه فى مسائل ال **Girders** لن نحتاج لحساب **Reactions** الكمرات الثانويه المحموله فوق الاعمده

هذه الاحمال تذهب مباشره الى الاعمده



B_2



Load For Shear = Load For moment

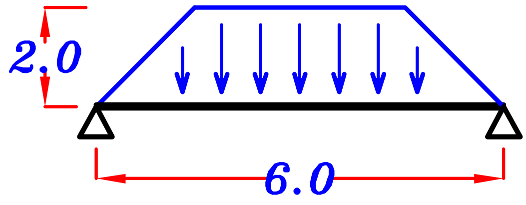
$$w_a = w_e = O.W. + \boxed{w_s}\ \frac{L_s}{2}$$

$$= 3.0 + (6.50)\left(\frac{2.8}{2}\right) = 12.10\ kN\backslash m'$$

$$R_2 = 12.10 * 6.0 = 72.60\ kN$$

$$\boxed{R_2 = 72.60\ kN}$$

B_3



For Trapezoid

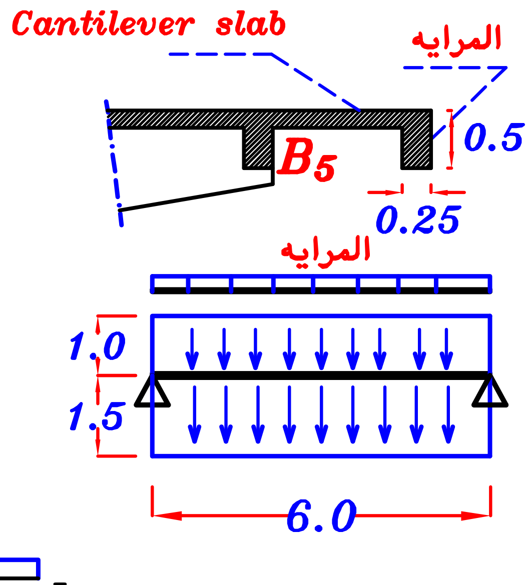
$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{6}\right) = \frac{2}{3}$$

$$w_a = O.W. + C_a\, w_s\, \frac{L_s}{2} = 3.0 + \frac{2}{3}(6.50)\left(\frac{4}{2}\right) = 11.66\ kN\backslash m'$$

$$R_3 = 11.66 * 6.0 = 70.0\ kN$$

$$\boxed{R_3 = 70.0\ kN}$$

B_5



وزن المرايه

$$b\ t\ \gamma_c = (0.25)(0.5)(25) = 3.12\ kN\backslash m'$$

المرايه محمولة على ال Cantilever slab و ال Cantilever slab محمولة على B_5

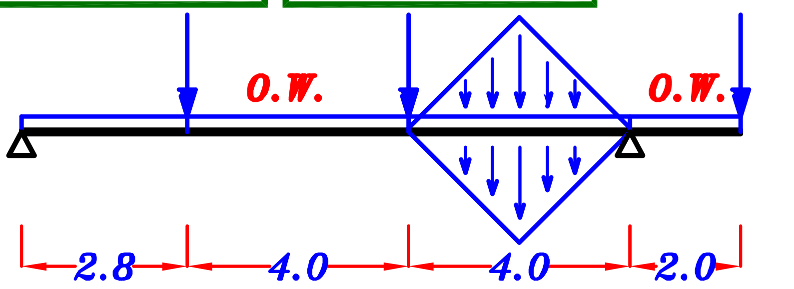
$$w_a = O.W.(\text{الكمره}) + O.W.(\text{المرايه}) + \boxed{w_s}\ L_c + \boxed{w_s}\ \frac{L_s}{2}$$

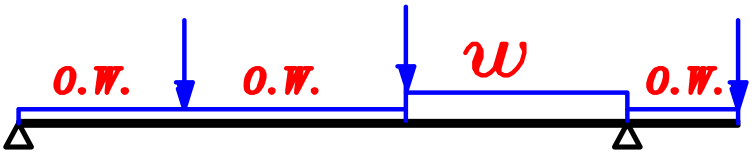
$$= 3.0 + 3.12 + (6.50)(1.5) + (6.50)\left(\frac{2}{2}\right) = 22.37\ kN\backslash m'$$

$$R_5 = 22.37 * 6.0 = 134.22\ kN$$

$$\boxed{R_5 = 134.22\ kN}$$

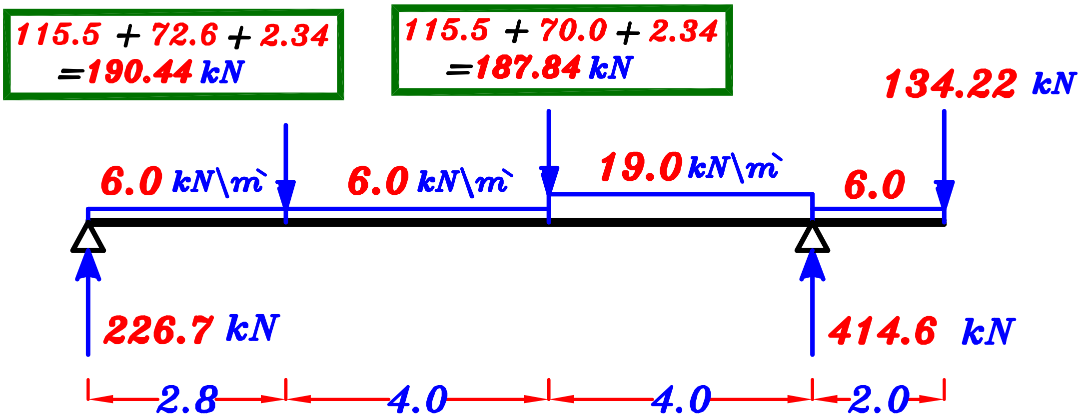
Girder (G)



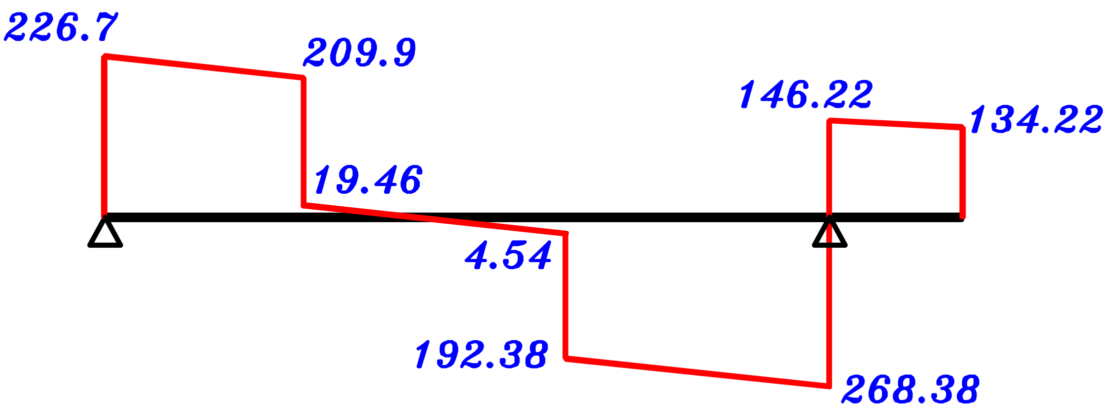


$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(4)(2)\right)}{4} = 2.0$$

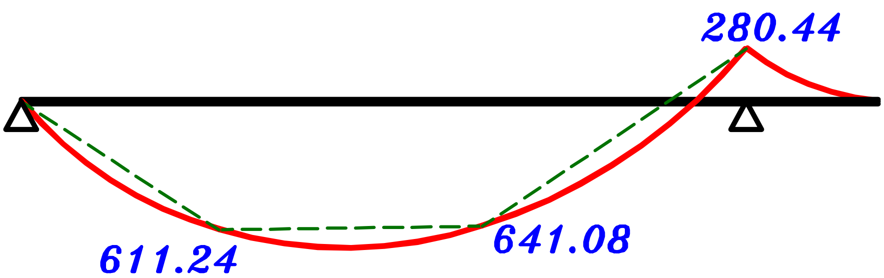
$$w_a = w_e = O.W. + \frac{\sum area}{span} * w_s = 6.0 + 2.0\,(6.50) = 19.0 \text{ kN\m`}$$



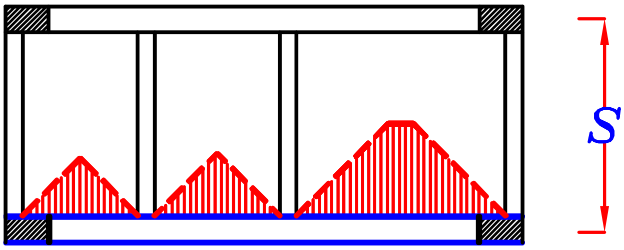
S.F.D.



B.M.D.



ملاحظات هامه

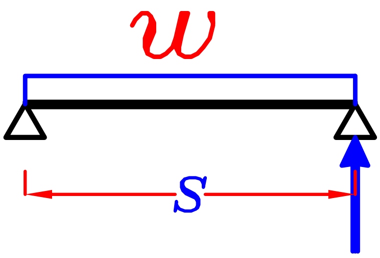


١- اذا كان عدد الـ ***Girders*** اثنان فقط

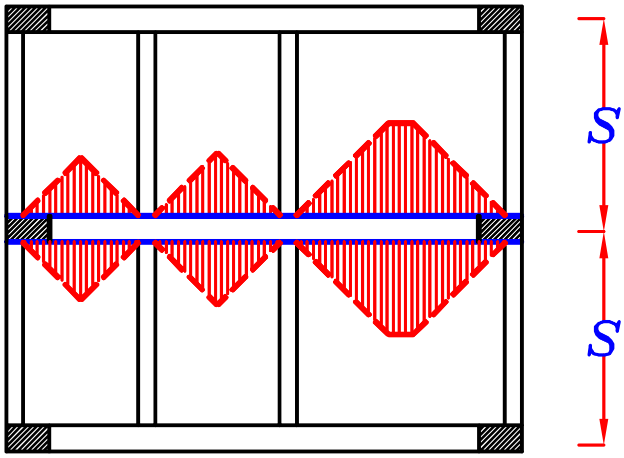
2 Girders only

فتكون الكمره الثانويه كمره ***Simple Beam***

فيكون ***Reaction*** الكمرات الثانويه $\boxed{\dfrac{w * S}{2}}$



$$R = \frac{w * S}{2}$$



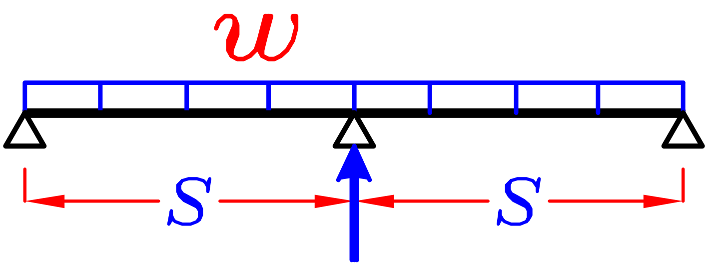
٢- اذا كان عدد الـ ***Girders*** ثلاثه

و مطلوب الـ ***Girder*** الاوسط

فتكون الكمره الثانويه كمره

Continuos 2 spans.

فيكون ***Reaction*** الكمرات الثانويه $\boxed{1.2\, w * S}$



$$R = 1.2\, w * S$$

خطوات مسأله ال cross-section (max-max)

١- نستنتج ال *Plan*

٢- نرسم خطوط توزيع ال *Loads* (*Load Distribution*)

٣- نسمى الكمرات ...... B_1 ، B_2 ، B_3

٤- نحسب g_s , p_s

٥- نحسب *Load For Shear* للكمرات الثانويه

و نحدد ال *Reactions* $\boxed{R_T = w * S}$, $\boxed{R_D = g * S}$

٦- نضع الاحمال على ال *Girder* بالترتيب التالى :-

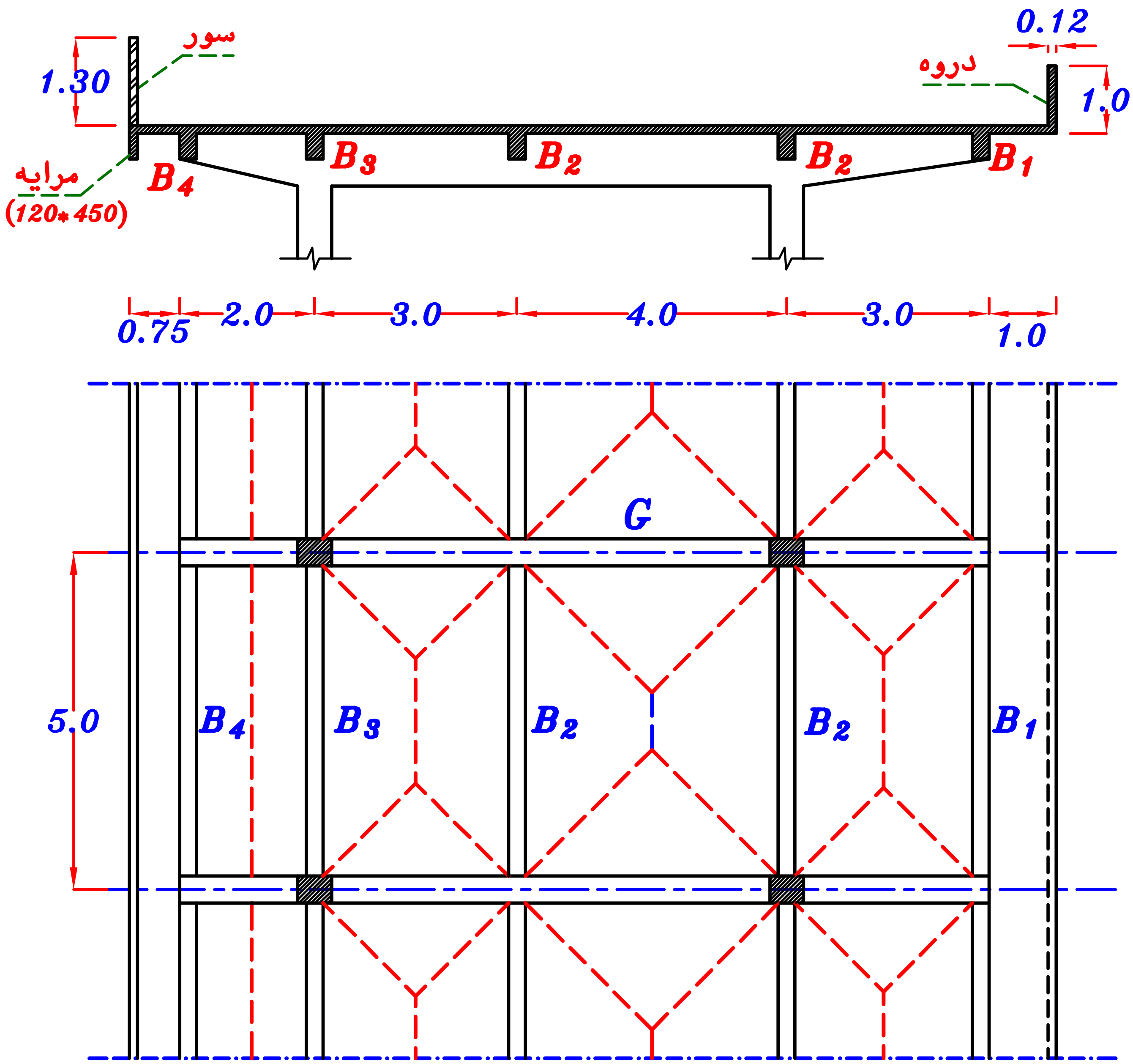
أ - نضع .o.w على ال *Girder* كله .

ب - نضع *Reactions* الكمرات الثانويه *concentrated loads* على ال *Girder*

ج - نضع أحمال البلاطه التى تنتقل مباشره من البلاطه الى ال *Girder* .
و تظهر هذه الاحمال من ال *plan*.

٧- نرسم *B.M.D. & S.F.D.* لل *Girder*

Example.



Data.

$t_s = 0.12$ m F.C. $= 1.50$ kN\m² L.L. $= 2.0$ kN\m²

O.W. of Girder $= 5.0$ kN\m`  O.W. of Beam $= 3.0$ kN\m`

O.W. Walls $= 3.0$ kN\m² Spacing $= 5.0$ m

Req.

1- Draw max.-max. S.F.D. & B.M.D. For B_2

2- Draw S.F.D. & max.-max. B.M.D. For the Girder.
(using woking Loads)

3- Draw max.-max. B.M.D. For the Girder.
(using Ultimate Limits Loads)

g_s , p_s

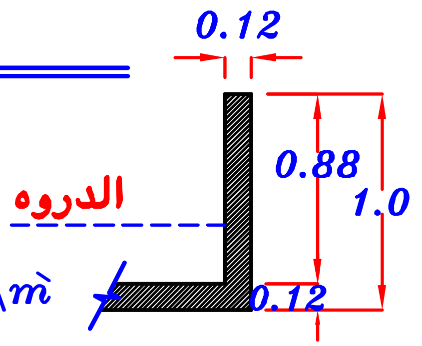
$$D.L. = g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \ kN\backslash m^2$$

$$L.L. = p_s = L.L. = 2.0 \ kN\backslash m^2$$

$$T.L. = w_s = g_s + p_s = 6.50 \ kN\backslash m^2$$

$$\boxed{g_s = 4.50 \ kN\backslash m^2}, \quad \boxed{p_s = 2.0 \ kN\backslash m^2}$$

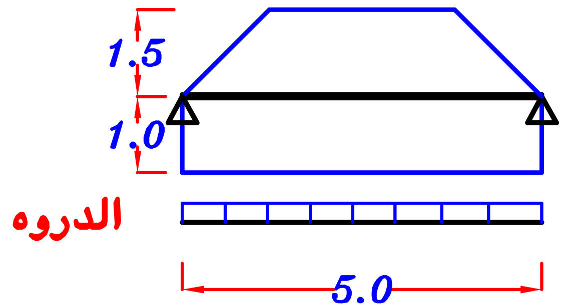
B_1



$$O.W. \ (Parapet) \ (الدروه) = (0.12)(0.88)(1.0)(25) = 2.64 \ kN\backslash m'$$

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3}{5}\right) = 0.70$$



Load For Shear.

$$g_a = O.W.(الكمرة) + O.W.(الدروه) + g_s L_c + C_a \ g_s \frac{L_s}{2}$$

$$= 3.0 + 2.64 + (4.50)(1.0) + (0.70)(4.50)\left(\frac{3}{2}\right) = 14.865 \ kN\backslash m'$$

$$p_a = p_s L_c + C_a \ p_s \frac{L_s}{2}$$

$$= (2.0)(1.0) + (0.70)(2.0)\left(\frac{3}{2}\right) = 4.10 \ kN\backslash m'$$

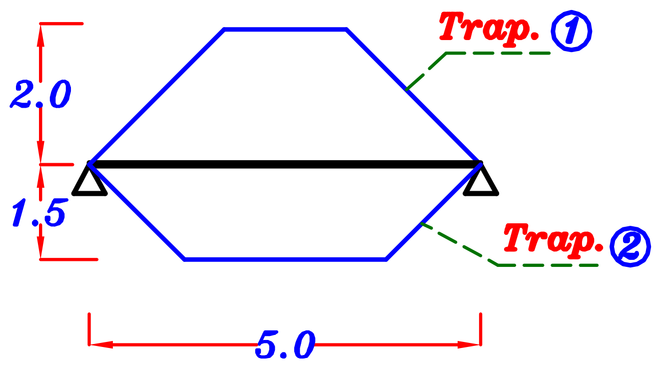
$$w_a = g_a + p_a = 14.865 + 4.10 = 18.965 \ kN\backslash m'$$

$$R_1 = g_a * Spacing = 14.865 * 5.0 = 74.325 \ kN \text{ ---- D.L.}$$

$$= w_a * Spacing = 18.965 * 5.0 = 94.825 \ kN \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_1 &= 74.325 \ kN \text{ ---- D.L.} \\ &= 94.825 \ kN \text{ ---- T.L.} \end{aligned}}$$

B_2



For Trapezoid 1

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{5}\right)^2 = 0.786$$

For Trapezoid 2

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3}{5}\right) = 0.70$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3}{5}\right)^2 = 0.88$$

Load For Shear.

$$g_a = O.W. + \underbrace{C_a\, g_s \frac{L_s}{2}}_{Trap. 1} + \underbrace{C_a\, g_s \frac{L_s}{2}}_{Trap. 2}$$

$$= 3.0 + (0.60)(4.50)\left(\frac{4}{2}\right) + (0.70)(4.50)\left(\frac{3}{2}\right) = 13.125 \text{ kN\m`}$$

$$p_a = \underbrace{C_a\, p_s \frac{L_s}{2}}_{Trap. 1} + \underbrace{C_a\, p_s \frac{L_s}{2}}_{Trap. 2}$$

$$= (0.60)(2.0)\left(\frac{4}{2}\right) + (0.70)(2.0)\left(\frac{3}{2}\right) = 4.50 \text{ kN\m`}$$

$$w_a = g_a + p_a = 13.125 + 4.50 = 17.625 \text{ kN\m`}$$

Load For Moment.

$$g_e = O.W. + \underbrace{C_e\, g_s \frac{L_s}{2}}_{Trap. 1} + \underbrace{C_e\, g_s \frac{L_s}{2}}_{Trap. 2}$$

$$= 3.0 + (0.786)(4.50)\left(\frac{4}{2}\right) + (0.88)(4.50)\left(\frac{3}{2}\right) = 16.014 \text{ kN\m`}$$

$$p_e = \underbrace{C_e\, p_s \frac{L_s}{2}}_{Trap. 1} + \underbrace{C_e\, p_s \frac{L_s}{2}}_{Trap. 2}$$

$$= (0.786)(2.0)\left(\frac{4}{2}\right) + (0.88)(2.0)\left(\frac{3}{2}\right) = 5.784 \text{ kN\m`}$$

$$w_e = g_e + p_e = 16.014 + 5.784 = 21.80 \text{ kN\m`}$$

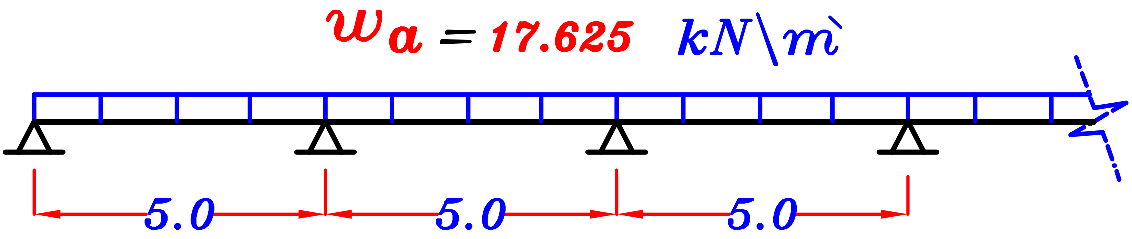
$R_2 = g_a * \text{Spacing} = 13.125 * 5.0 = 65.625$ kN ------ D.L.

$= w_a * \text{Spacing} = 17.625 * 5.0 = 88.125$ kN ------ T.L.

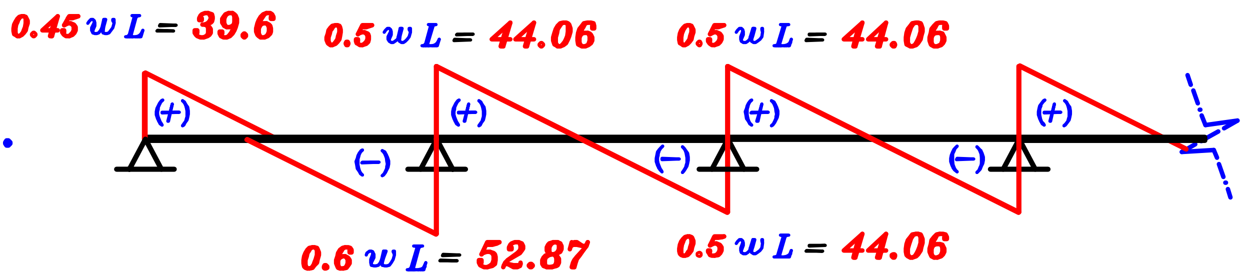
$$\boxed{\begin{aligned} R_2 &= 65.625 \text{ kN ---- D.L.} \\ &= 88.125 \text{ kN ---- T.L.} \end{aligned}}$$

max–max S.F.D. For B_2

Load For Shear

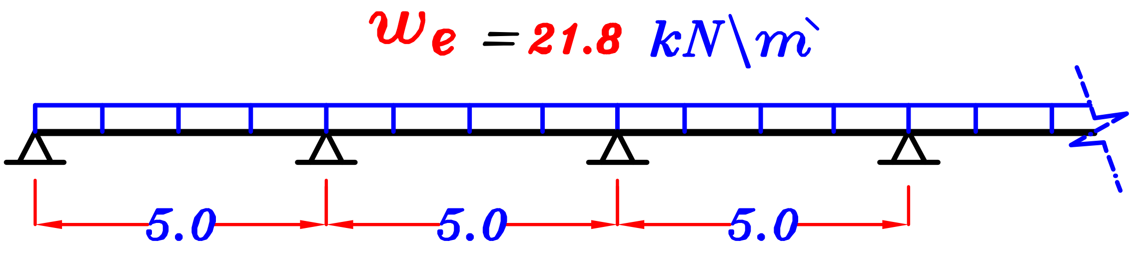


S.F.D.

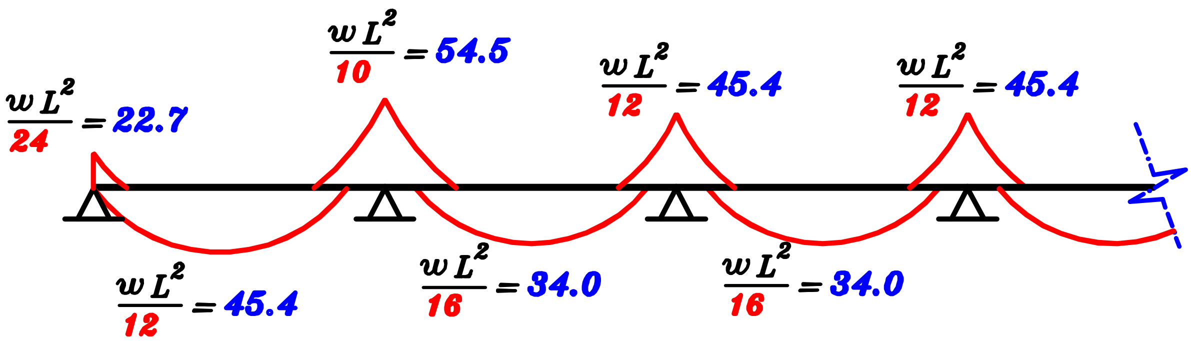


max–max B.M.D. For B_2

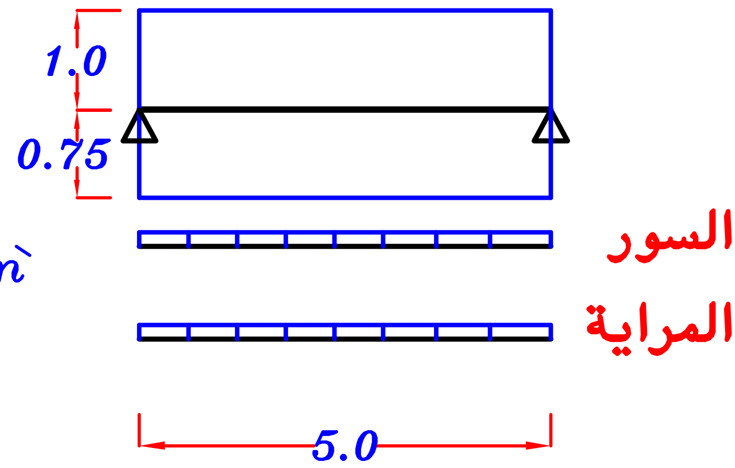
Load For Moment.



B.M.D.



B_4



O.W. (السور) $= h_w * \gamma_w$

$$= (1.3)(3.0) = 3.90 \ kN\backslash m'$$

O.W. (المراية) $= b \ t \ \gamma_c$

$$= (0.12)(0.45)(25) = 1.35 \ kN\backslash m'$$

Load For Shear.

$g_a =$ O.W. (الكمره) + O.W. (المراية) + O.W. (السور) $+ \ g_s \ L_c + g_s \ \frac{L_s}{2}$

$$= 3.0 + 1.35 + 3.90 + (4.50)(0.75) + (4.50)\left(\frac{2}{2}\right) = 16.125 \ kN\backslash m'$$

$$p_a = p_s \ L_c + p_s \ \frac{L_s}{2}$$

$$= (2.0)(0.75) + (2.0)\left(\frac{2}{2}\right) = 3.50 \ kN\backslash m'$$

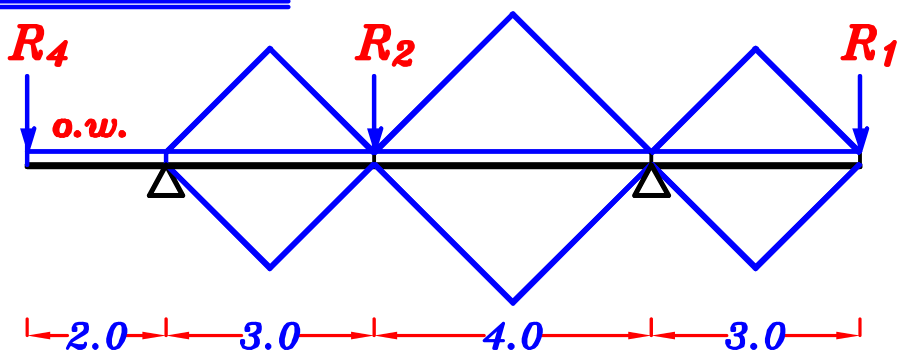
$$w_a = g_a + p_a = 16.125 + 3.50 = 19.625 \ kN\backslash m'$$

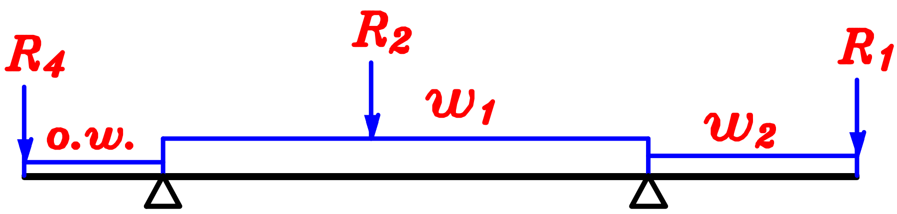
$R_4 = g_a * \text{Spacing} = 16.125 * 5.0 = 80.625 \ kN$ ---- D.L.

$\quad = w_a * \text{Spacing} = 19.625 * 5.0 = 98.125 \ kN$ ---- T.L.

$$\boxed{\begin{aligned} R_4 &= 80.625 \ kN \text{ ---- D.L.} \\ &= 98.125 \ kN \text{ ---- T.L.} \end{aligned}}$$

Loads on the girder.





Loads on the mid. Span. (w_1)

$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3)(1.5)\right) + 2\left(\frac{1}{2}(4)(2)\right)}{7.0} = 1.785$$

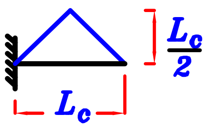
$$g_1 = g_a = g_e = o.w. + \frac{\sum area}{span} * g_s = 5.0 + 1.785\ (4.50) = 13.03\ kN\backslash m'$$

$$p_1 = p_a = p_e = \frac{\sum area}{span} * p_s = 1.785\ (2.0) = 3.57\ kN\backslash m'$$

$$w_1 = w_a = w_e = g_1 + p_1 = 13.03 + 3.57 = 16.60\ kN\backslash m'$$

$$\boxed{\begin{array}{l} g_1 = 13.03\ kN\backslash m' \text{ --- D.L.} \\ w_1 = 16.60\ kN\backslash m' \text{ --- T.L.} \end{array}}$$

Loads on the right Cantilever. (w_2)



$C_a = C_e = \frac{1}{2}$ Load For Shear = Load For Moment

$$g_2 = o.w. + 2\left[C_a\ g_s\ \frac{L_c}{2}\right] = 5.0 + 2\left[\left(\frac{1}{2}\right)(4.50)\left(\frac{3}{2}\right)\right] = 11.75\ kN\backslash m'$$

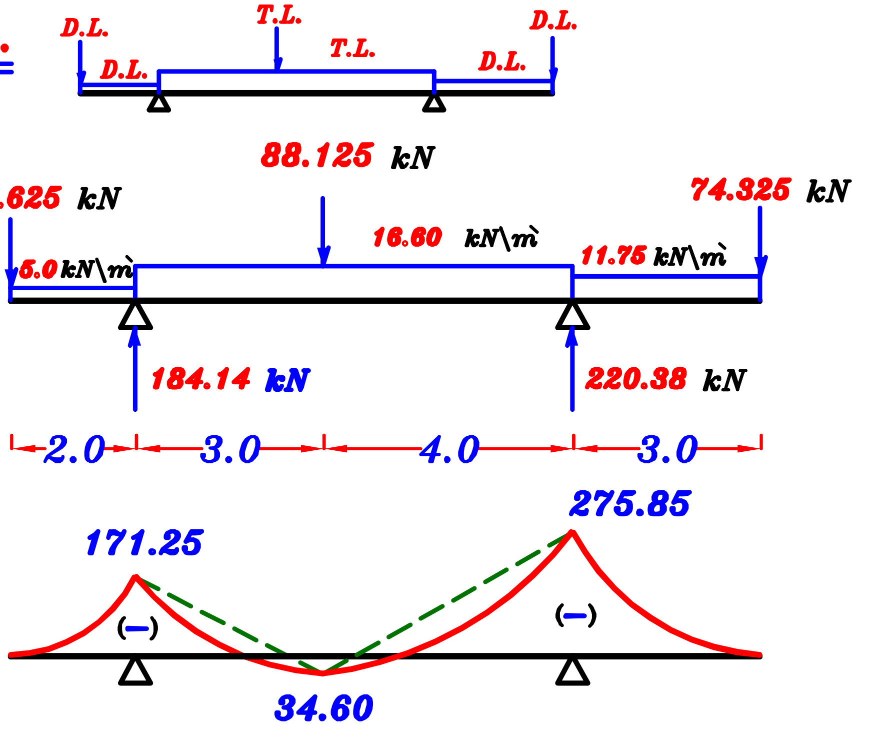
$$p_2 = 2\left[C_a\ p_s\ \frac{L_c}{2}\right] = 2\left[\left(\frac{1}{2}\right)(2.0)\left(\frac{3}{2}\right)\right] = 3.0\ kN\backslash m'$$

$$w_2 = g_2 + p_2 = 11.75 + 3.0 = 14.75\ kN\backslash m'$$

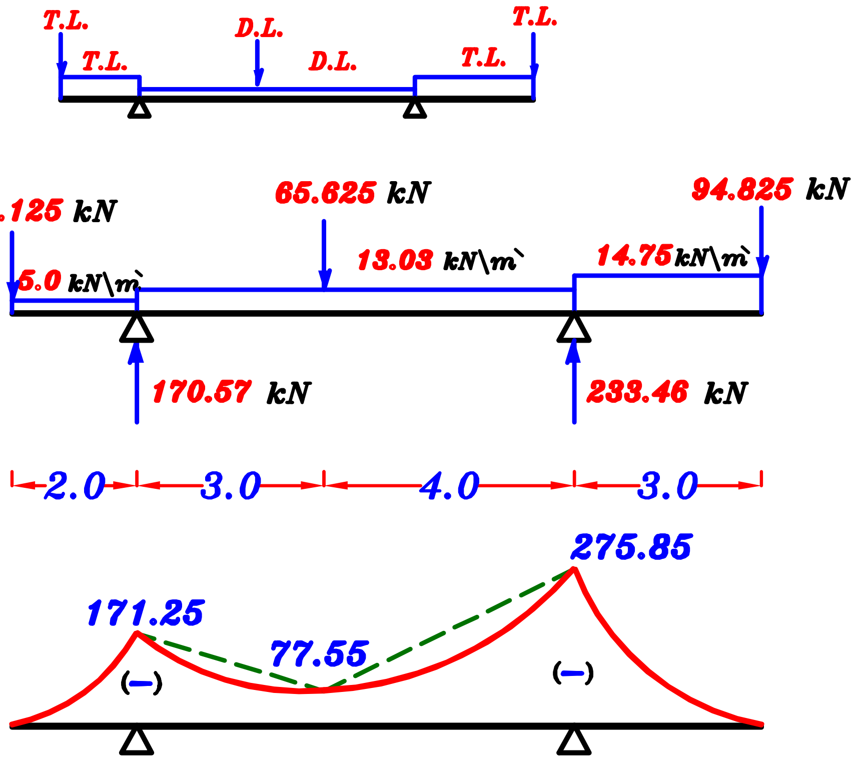
$$\boxed{\begin{array}{l} g_2 = 11.75\ kN\backslash m' \text{ --- D.L.} \\ w_2 = 14.75\ kN\backslash m' \text{ --- T.L.} \end{array}}$$

max-max B.M.D. For the Girder. (using woking Loads)

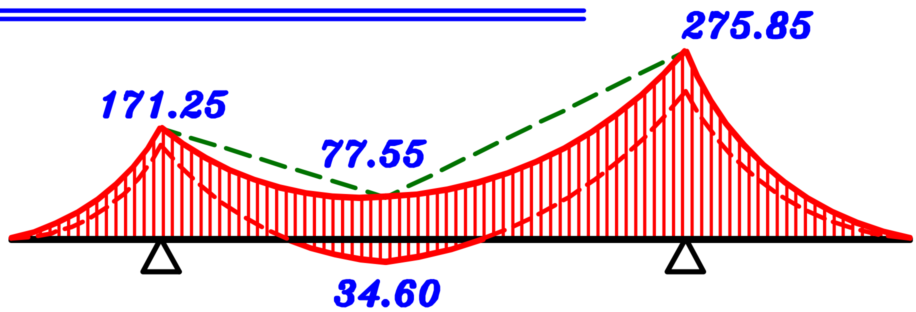
1- max. +ve B.M.D.



2- max. −ve B.M.D.

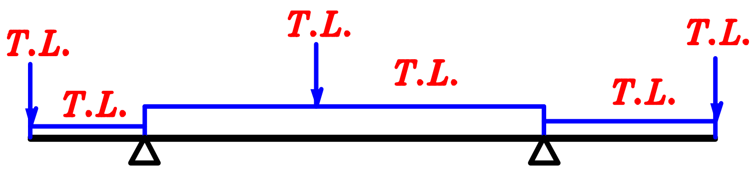


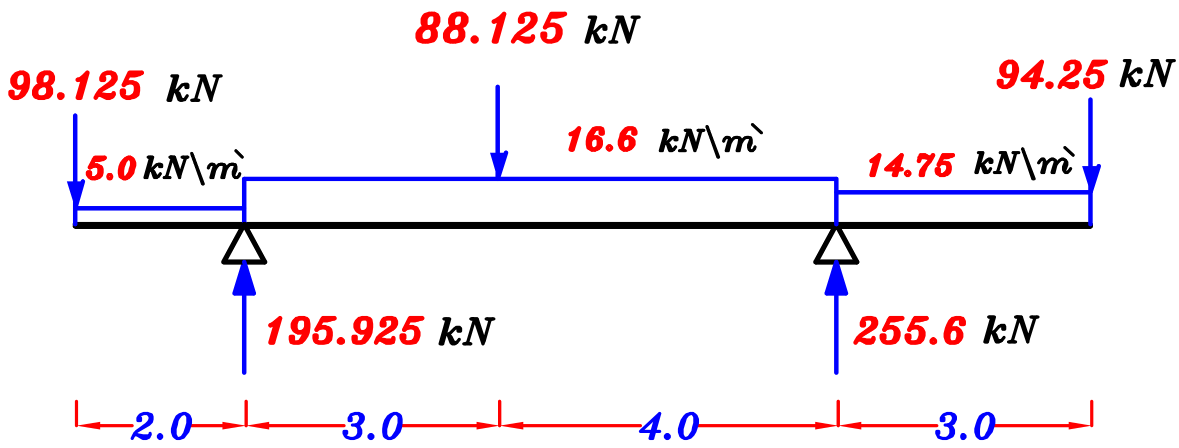
max-max B.M.D. For the Girder.

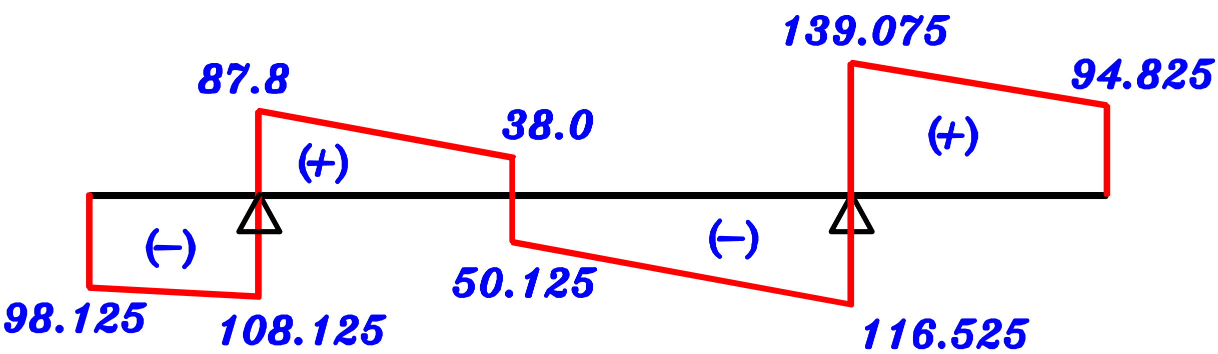


S.F.D. For the Girder.

Take Total Load on all the spans.



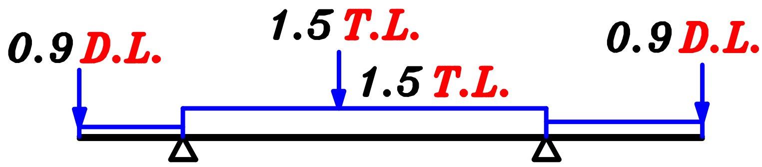


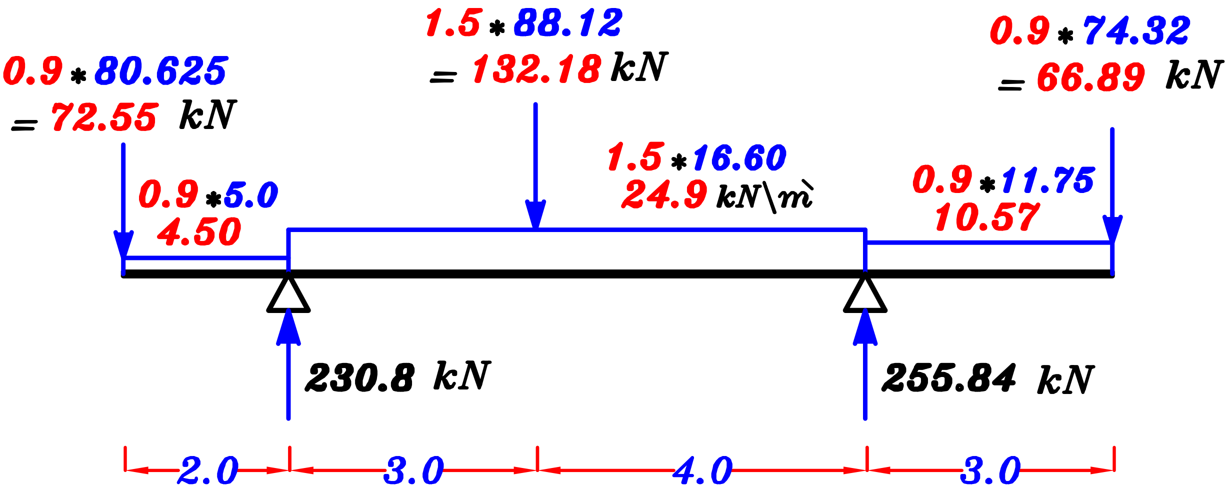


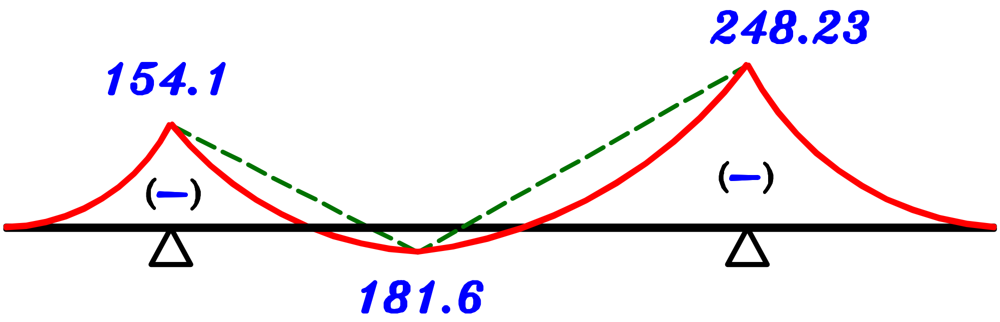
max–max B.M.D. For the Girder.

(using Ultimate Limits Loads)

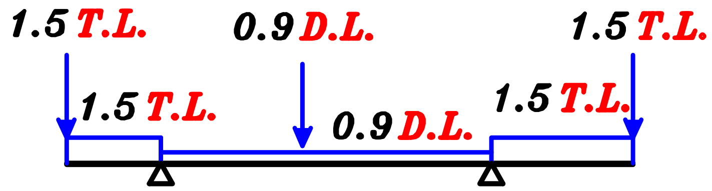
1- max. +Ve B.M.D.

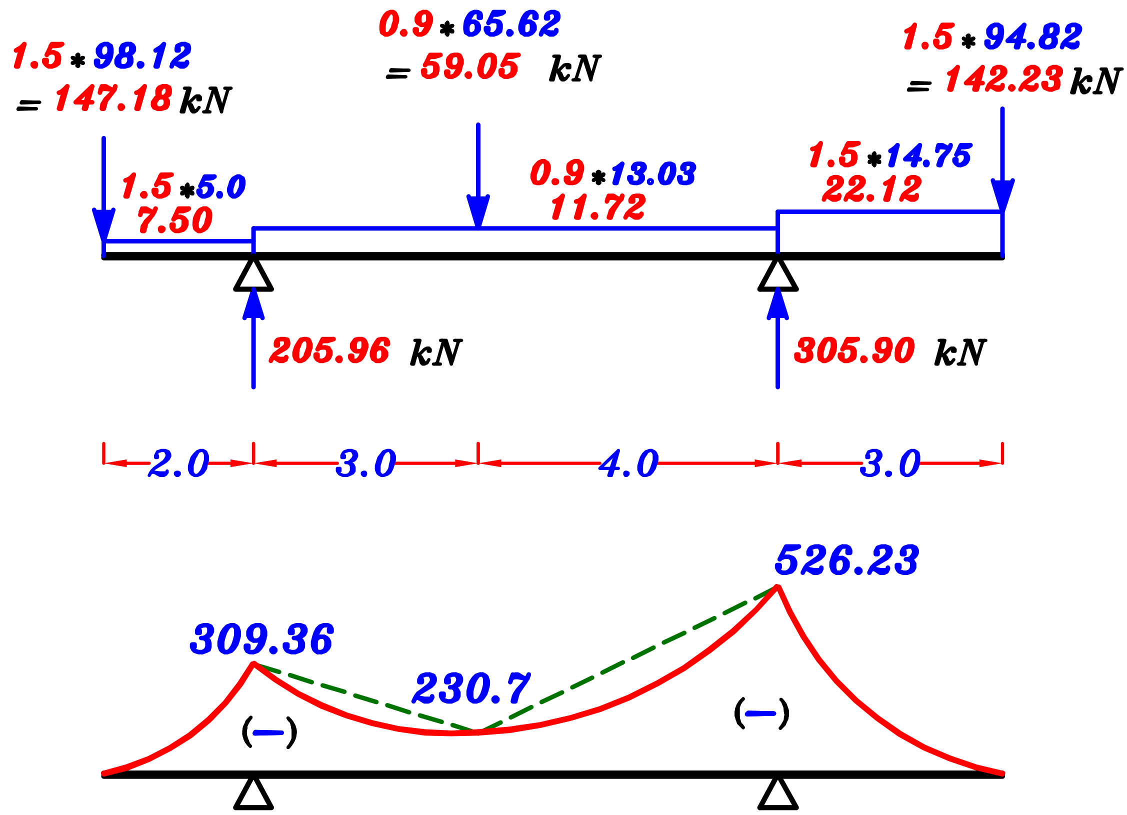






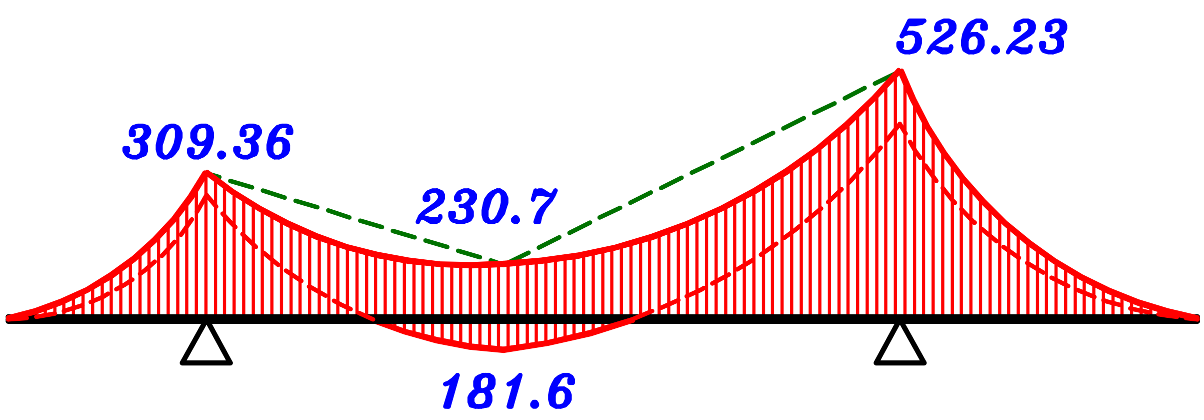
2- max. -Ve B.M.D.



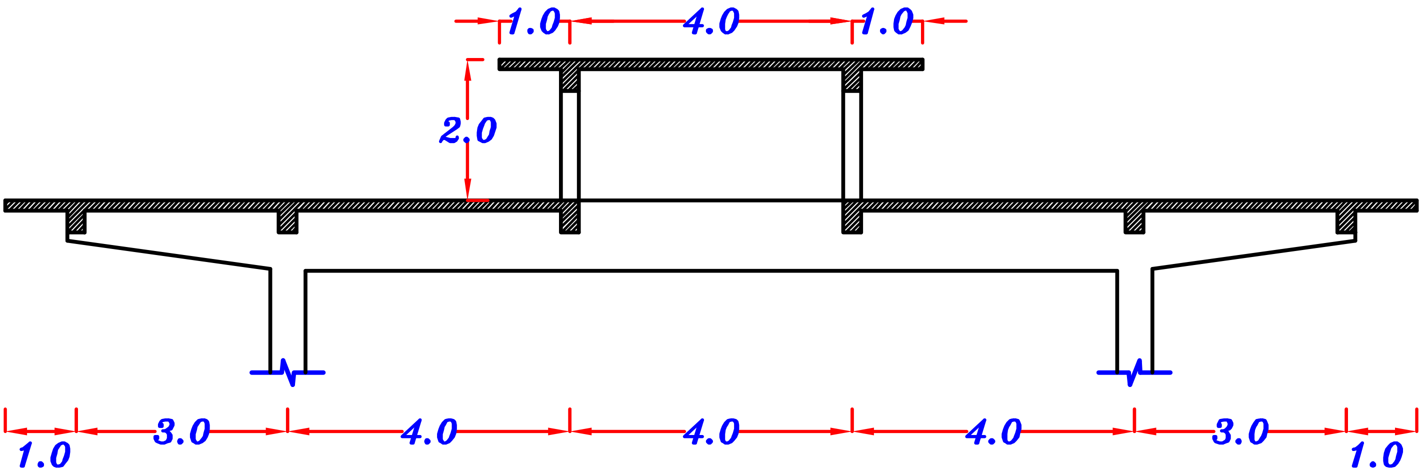


max-max B.M.D. For the Girder.

(using Ultimate Limits Loads)



Example.



a- Draw structural plan showing the pattern of load distribution.

b- Calculate the equivalent working loads For shear and moment For an interior girder (G).

c- Draw the maximum-maximum bending moment on the girder (G). (using working loads).

d- Draw the maximum-maximum bending moment on the girder (G). (using ultimat limits loads).

e- Draw the shearing Force diagram For the girder (G) For the case of the total load only. (using working loads).

Data :

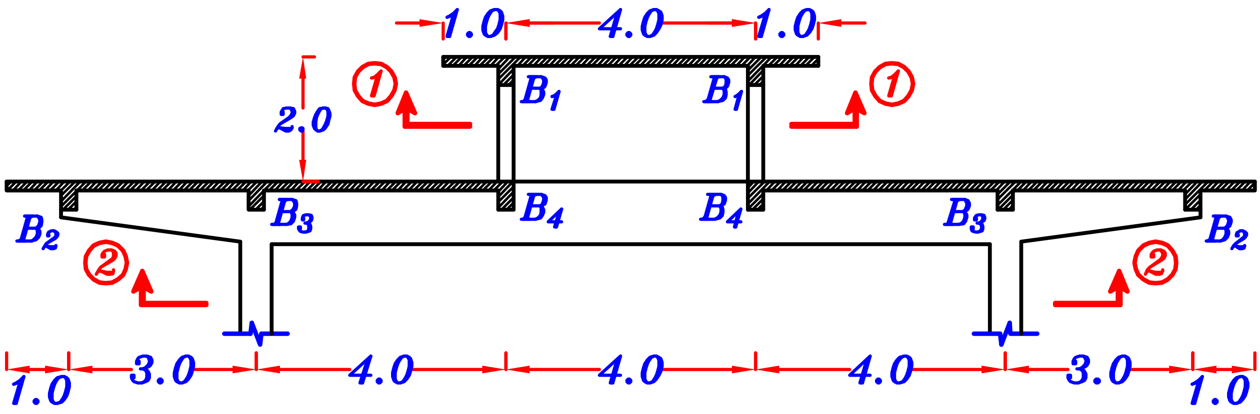
$t_s = 0.12\ m$

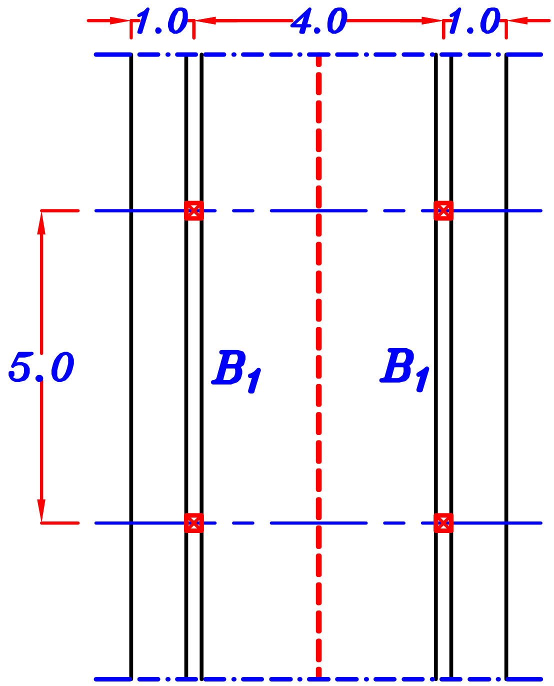
$F.C. = 1.0\ kN\backslash m^2$, $L.L. = 1.0\ kN\backslash m^2$

$o.w.(beams) = 3.0\ kN\backslash m'$, $o.w.(girder) = 6.0\ kN\backslash m'$

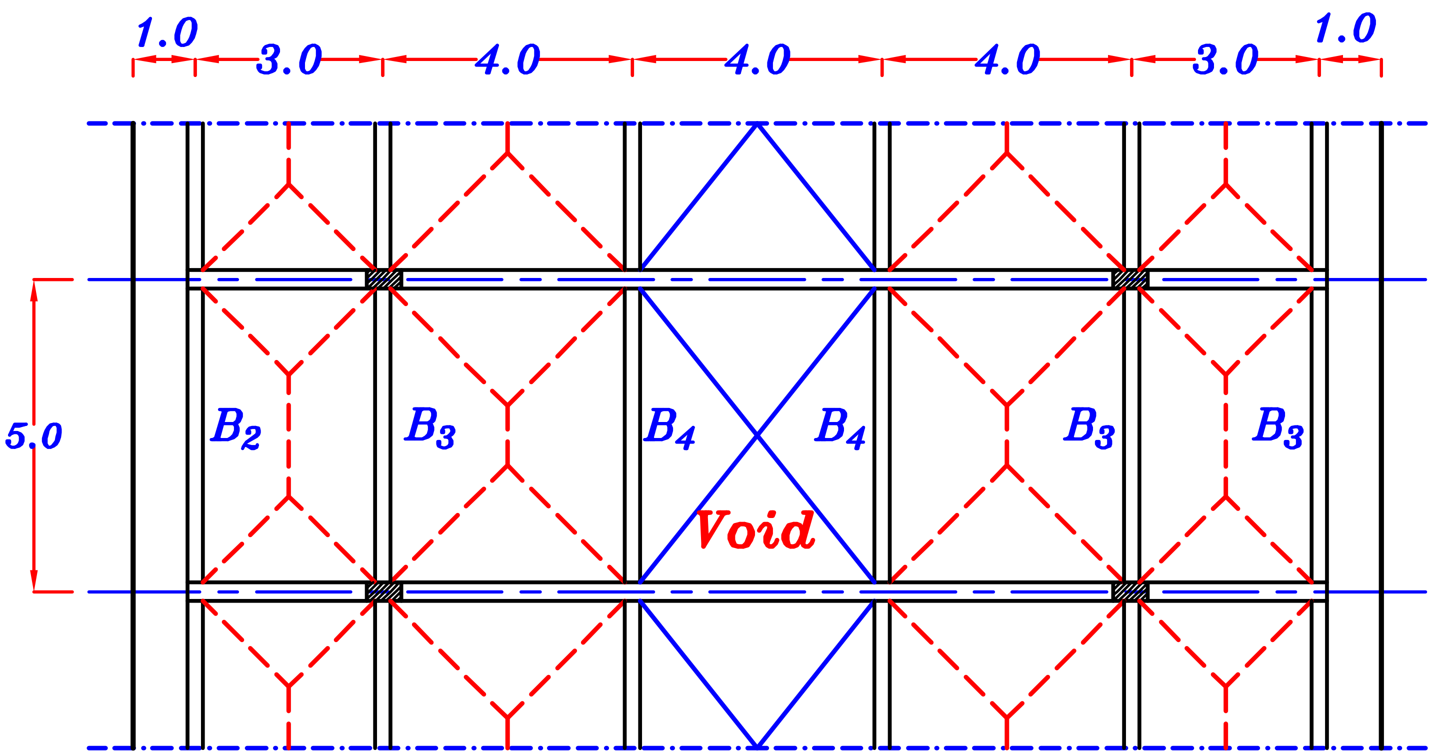
$b(beams) = 250\ mm$, $b(girder) = 300\ mm$

1- Structural plans.





Plan ①



Plan ②

g_s , p_s

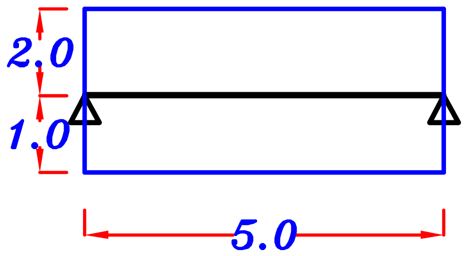
$$D.L. = g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.0 = 4.0 \ kN\backslash m^2$$

$$L.L. = p_s = L.L. = 1.0 \ kN\backslash m^2$$

$$T.L. = w_s = g_s + p_s = 5.0 \ kN\backslash m^2$$

$$\boxed{g_s = 4.0 \ kN\backslash m^2} \quad , \quad \boxed{p_s = 1.0 \ kN\backslash m^2}$$

B_1 Load For Shear.



$$g_a = O.W. + g_s L_c + g_s \frac{L_s}{2}$$

$$= 3.0 + (4.0)(1.0) + (4.0)\left(\frac{4}{2}\right) = 15.0 \ kN\backslash m'$$

$$p_a = p_s L_c + p_s \frac{L_s}{2} = (1.0)(1.0) + (1.0)\left(\frac{4}{2}\right) = 3.0 \ kN\backslash m'$$

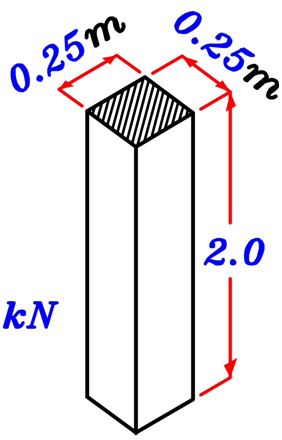
$$w_a = g_a + p_a = 15.0 + 3.0 = 18.0 \ kN\backslash m'$$

$$R_1 = g_a * Spacing = 15.0 * 5.0 = 75.0 \ kN \text{ ----- } D.L.$$

$$= w_a * Spacing = 18.0 * 5.0 = 90.0 \ kN \text{ ----- } T.L.$$

$$\boxed{\begin{aligned} R_1 &= 75.0 \ kN \text{ ---- } D.L. \\ &= 90.0 \ kN \text{ ---- } T.L. \end{aligned}}$$

Post



Weight of the Post = Volume * Density

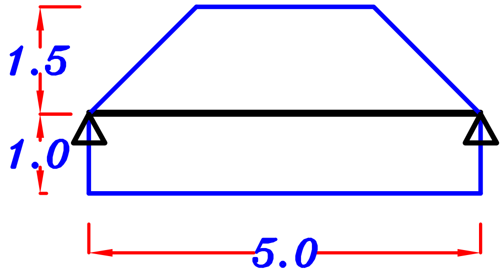
$$= (0.25 * 0.25 * 2.0)(25) = 3.10 \ kN$$

$$\boxed{\text{Weight of the Post} = 3.10 \ kN}$$

B_2

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3}{5}\right) = 0.70$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + g_s L_c = 3.0 + (0.70)(4.0)\left(\frac{3}{2}\right) + (4.0)(1.0) = 11.2\ kN\backslash m`$$

$$p_a = C_a\, p_s \frac{L_s}{2} + p_s L_c = (0.70)(1.0)\left(\frac{3}{2}\right) + (1.0)(1.0) = 2.05\ kN\backslash m`$$

$$w_a = g_a + p_a = 11.2 + 2.05 = 13.25\ kN\backslash m`$$

$$R_2 = g_a * Spacing = 11.2 * 5.0 = 56.0\ kN \text{ ----- } D.L.$$

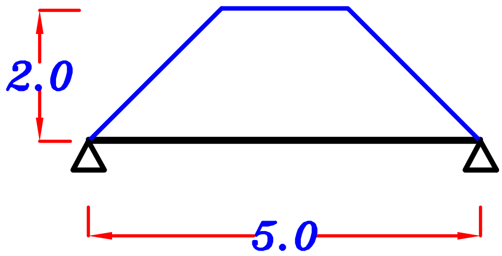
$$= w_a * Spacing = 13.25 * 5.0 = 66.25\ kN \text{ ----- } T.L.$$

$$\boxed{\begin{aligned} R_2 &= 56.0\ kN \text{ ---- } D.L. \\ &= 66.25\ kN \text{ ---- } T.L. \end{aligned}}$$

B_4

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} = 3.0 + (0.60)(4.0)\left(\frac{4}{2}\right) = 7.8\ kN\backslash m`$$

$$p_a = C_a\, p_s \frac{L_s}{2} = (0.60)(1.0)\left(\frac{4}{2}\right) = 1.2\ kN\backslash m`$$

$$w_a = g_a + p_a = 7.80 + 1.20 = 9.0\ kN\backslash m`$$

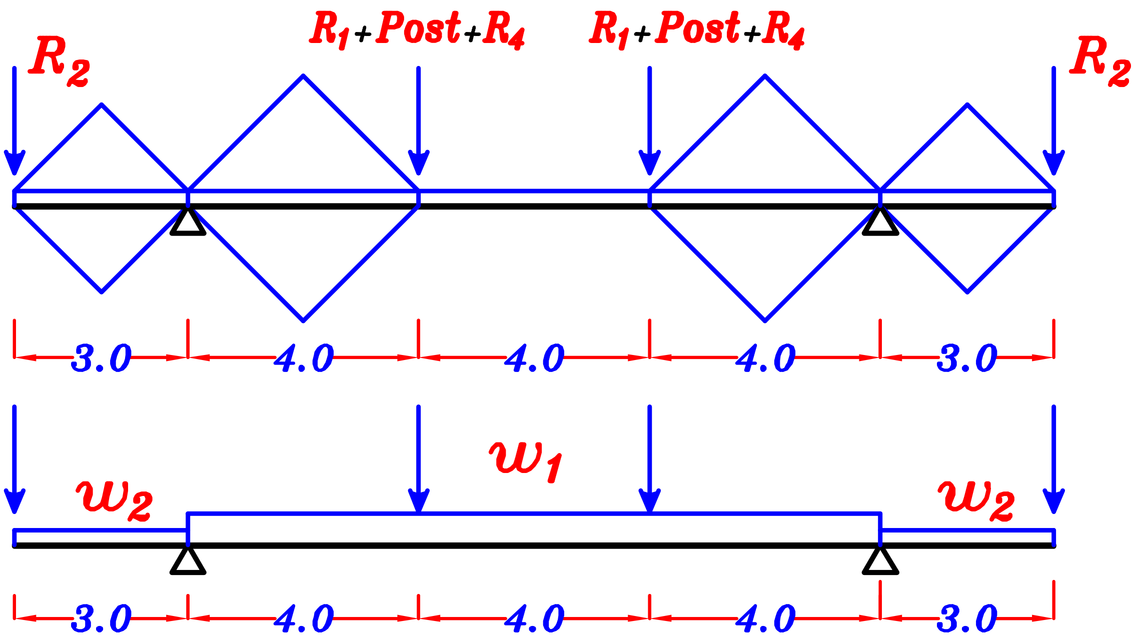
$$R_4 = g_a * Spacing = 7.8 * 5.0 = 39.0\ kN \text{ ----- } D.L.$$

$$= w_a * Spacing = 9.0 * 5.0 = 45.0\ kN \text{ ----- } T.L.$$

$$\boxed{\begin{aligned} R_4 &= 39.0\ kN \text{ ----- } D.L. \\ &= 45.0\ kN \text{ ----- } T.L. \end{aligned}}$$

G

Load on Girder.



w_1 Load For shear = Load For Moment

$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}\right)(4.0)(2.0)}{12.0} = \frac{4}{3}$$

$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + \left(\frac{4}{3}\right)(4.0) = 11.33 \ kN\backslash m'$$

$$p_1 = \frac{\sum area}{span} * p_s = \left(\frac{4}{3}\right)(1.0) = 1.33 \ kN\backslash m'$$

$$w_1 = g_1 + p_1 = 11.33 + 1.33 = 12.66 \ kN\backslash m'$$

$g_1 = 11.33$ kN\m' ---- D.L.
$w_1 = 12.66$ kN\m' ---- T.L.

w_2 For triangle $C_a = C_e = \frac{1}{2}$

$$g_a = g_e = o.w. + 2\, C_a\, g_s\, \frac{L_c}{2} = 6.0 + 2\left(\frac{1}{2}\right)(4.0)\left(\frac{3.0}{2}\right) = 12.0 \ kN\backslash m'$$

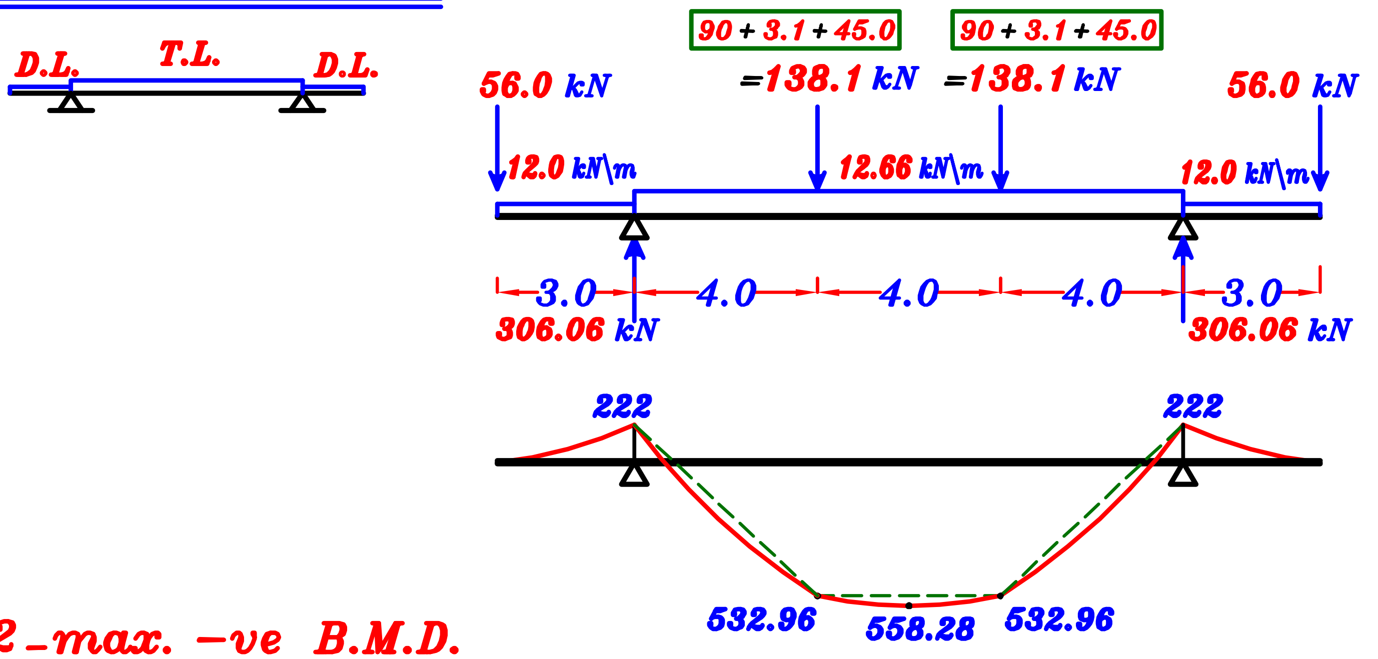
$$p_a = p_e = 2\, C_a\, p_s\, \frac{L_c}{2} = 2\left(\frac{1}{2}\right)(1.0)\left(\frac{3.0}{2}\right) = 1.50 \ kN\backslash m'$$

$$w_a = w_e = g_a + p_a = 12.0 + 1.50 = 13.5 \ kN\backslash m'$$

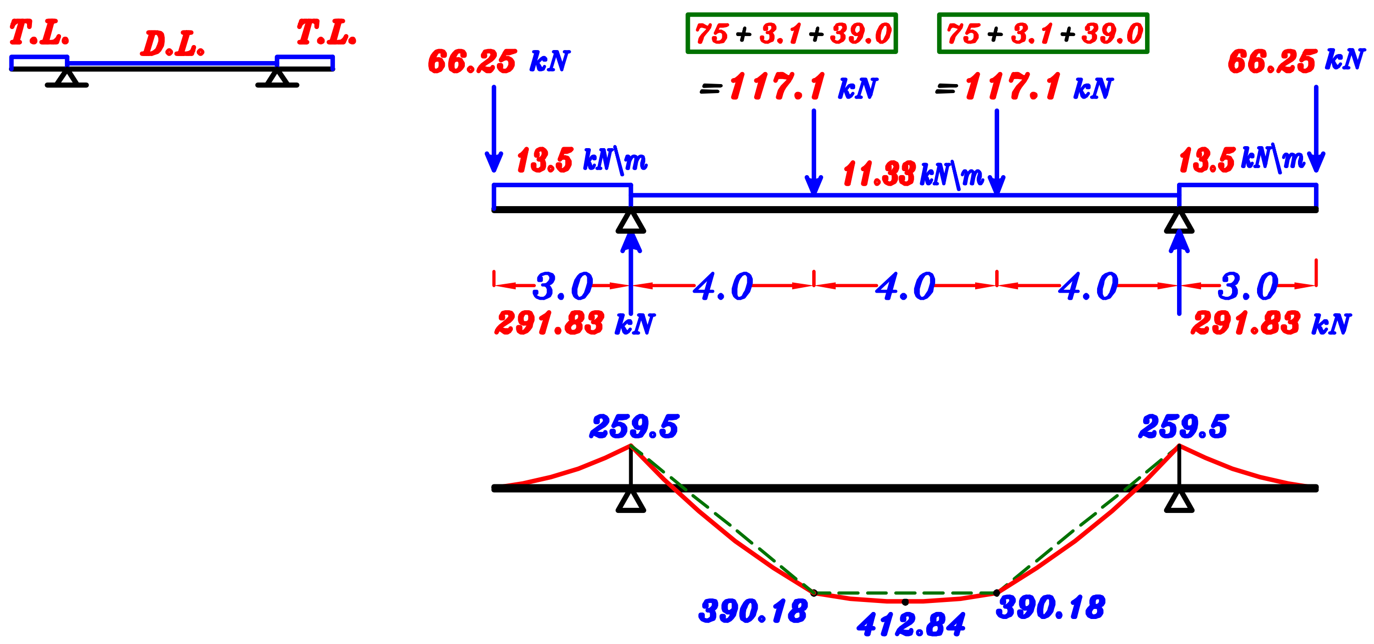
$g_2 = 12.0$ kN\m' ---- D.L.
$w_2 = 13.5$ kN\m' ---- T.L.

max-max B.M.D. on Girder (G) (using working loads)

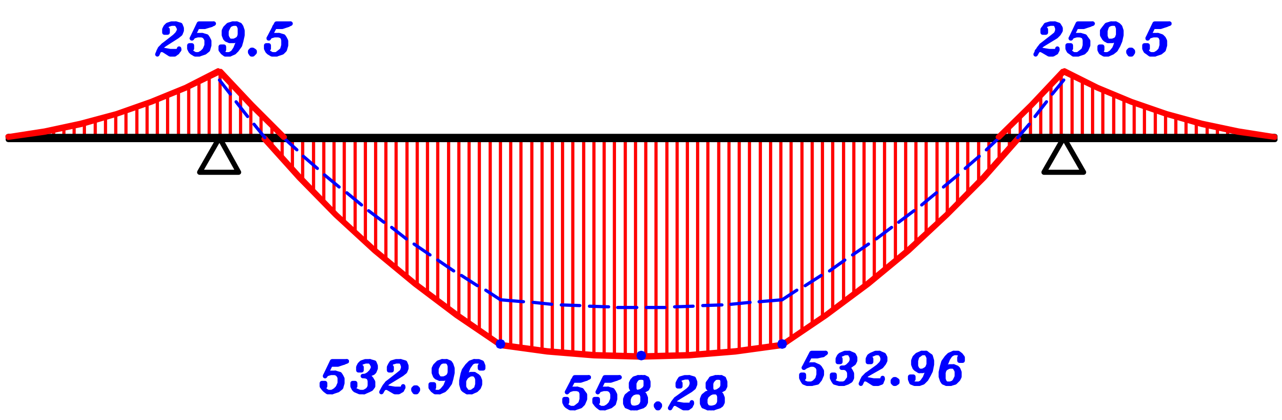
1- max. +ve B.M.D.



2- max. -ve B.M.D.

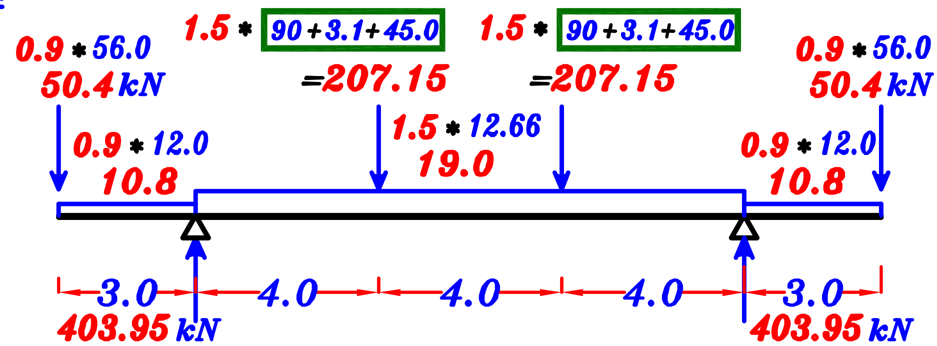


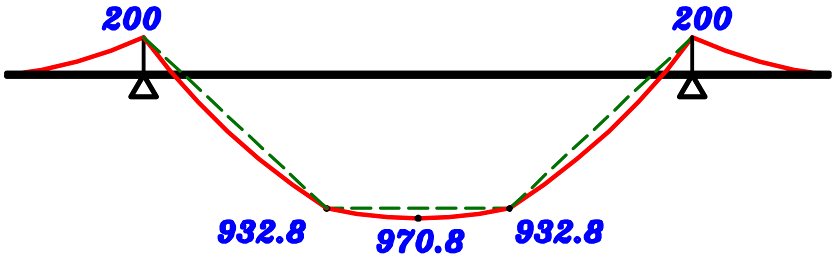
max-max B.M.D. For the Girder.



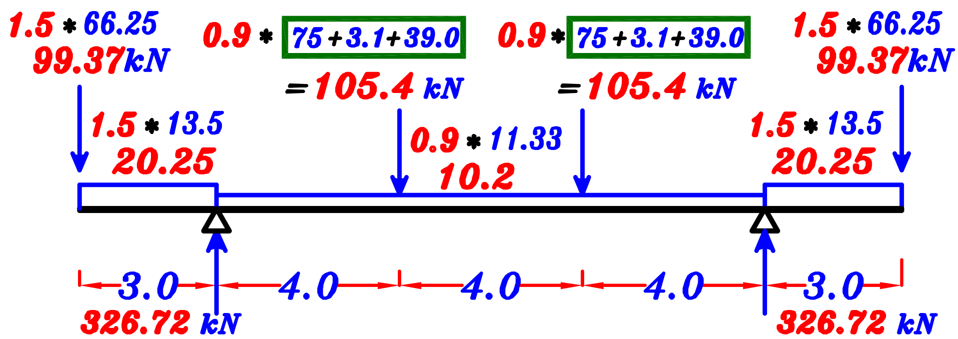
max-max B.M.D. on Girder (G) (using ultimate limits loads)

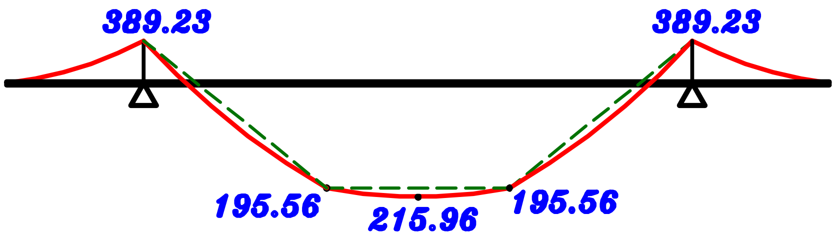
1- max. +ve B.M.D.



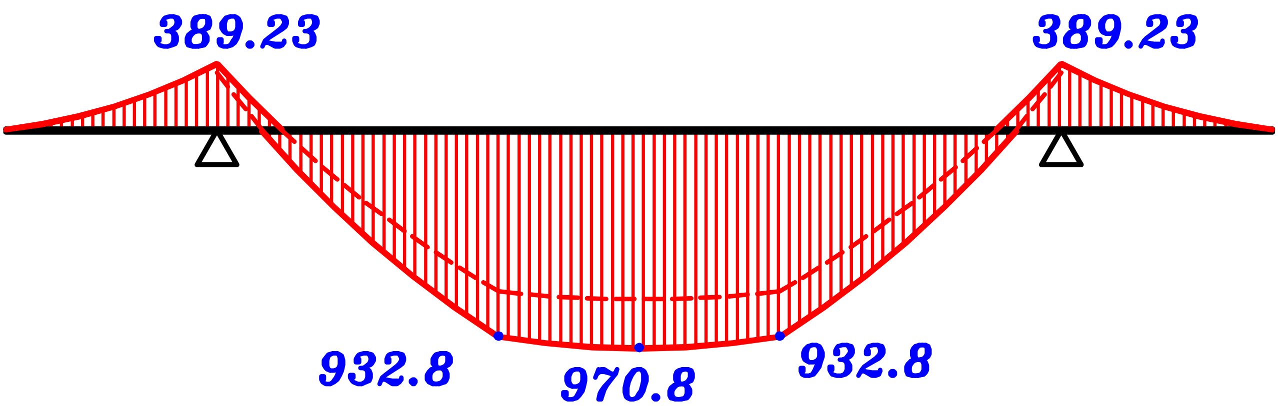


2- max. -ve B.M.D.

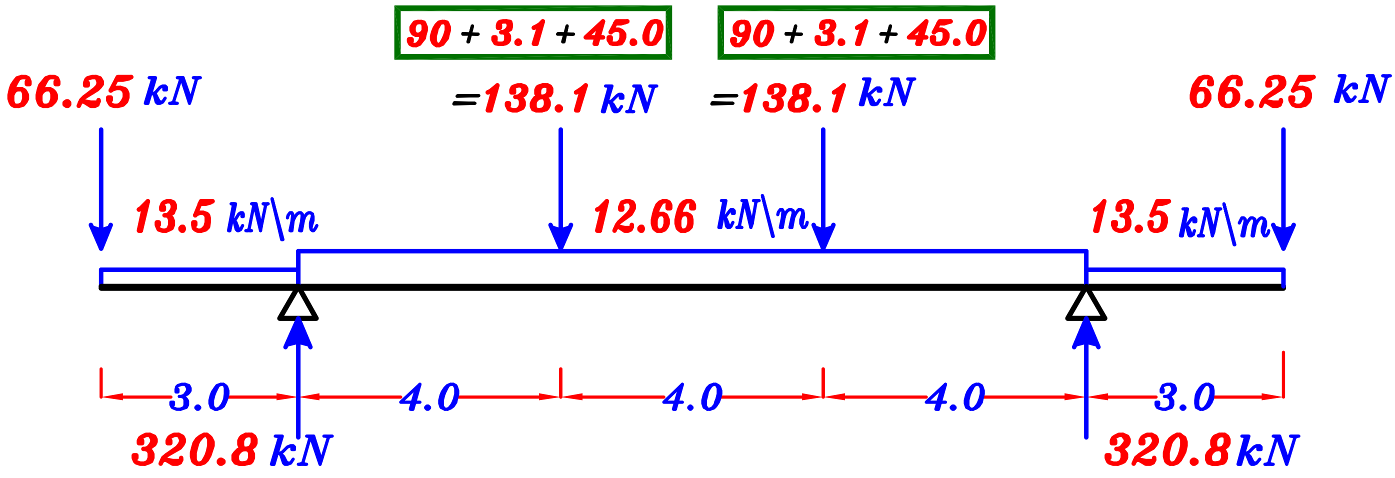


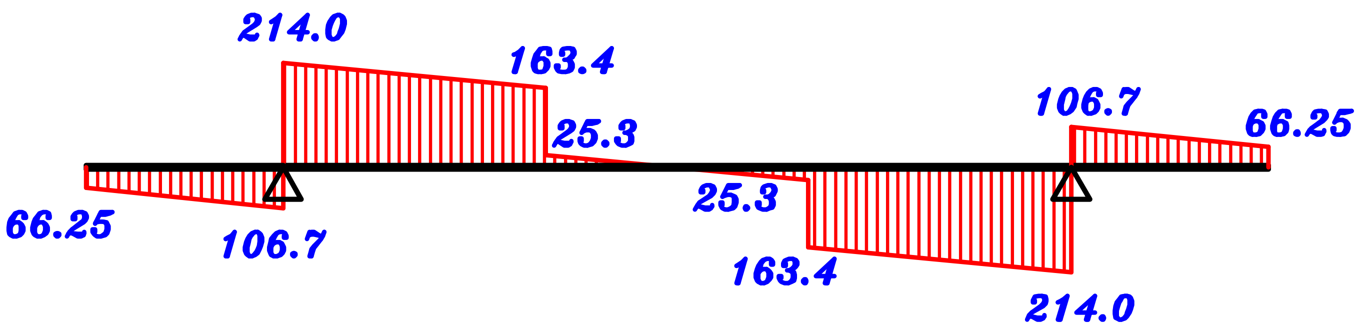


max-max B.M.D. For the Girder.



S.F.D. For the Girder (G) (using working loads)

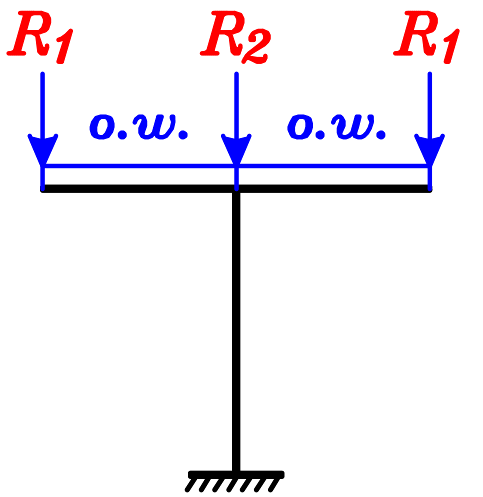


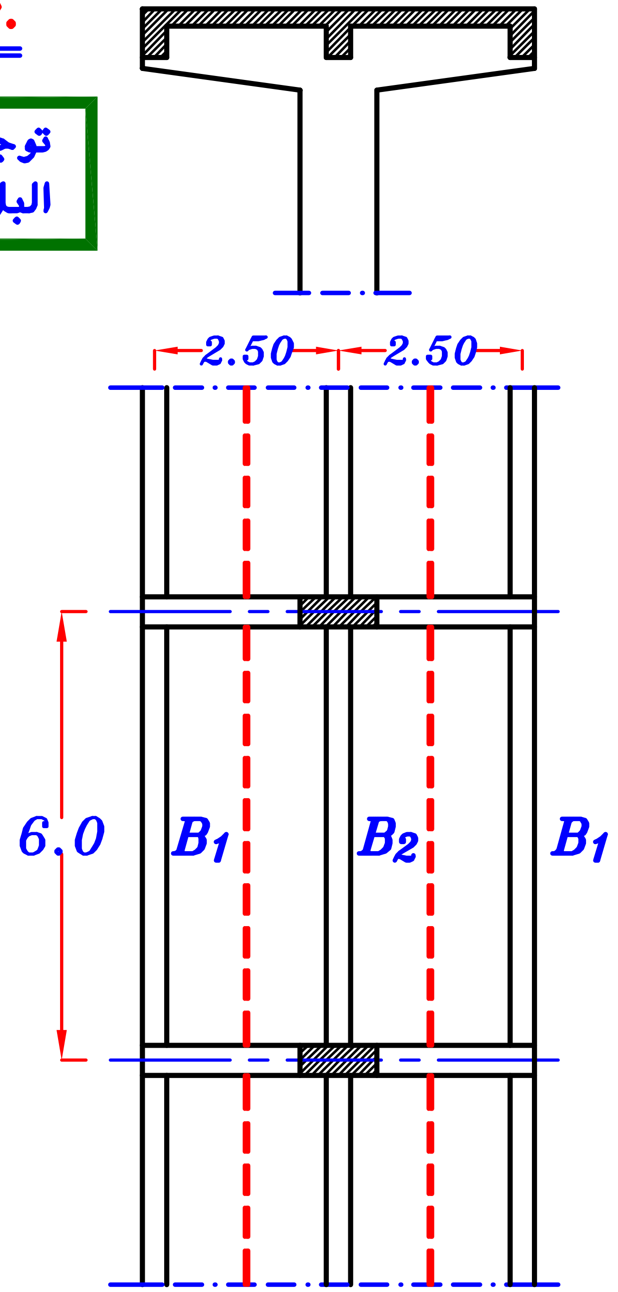


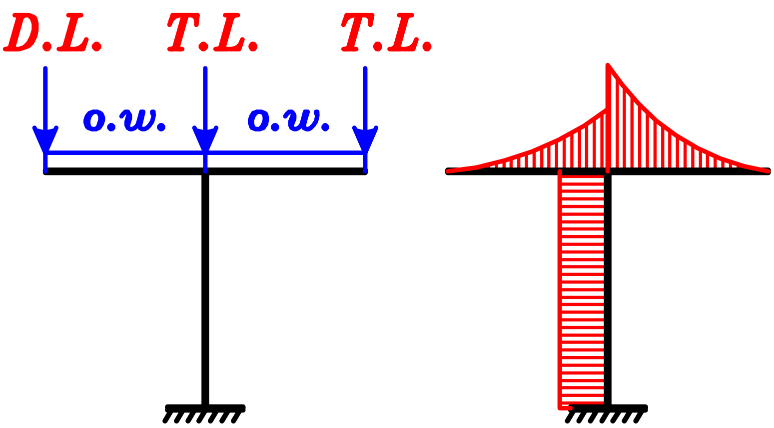
Notes.

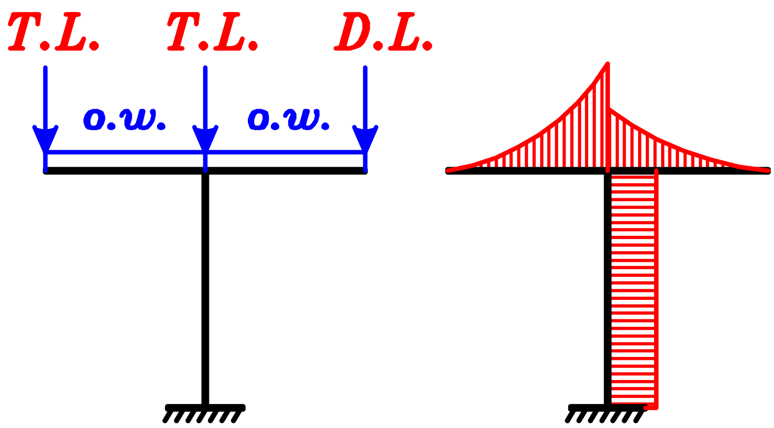
Double Cantilever Frame.

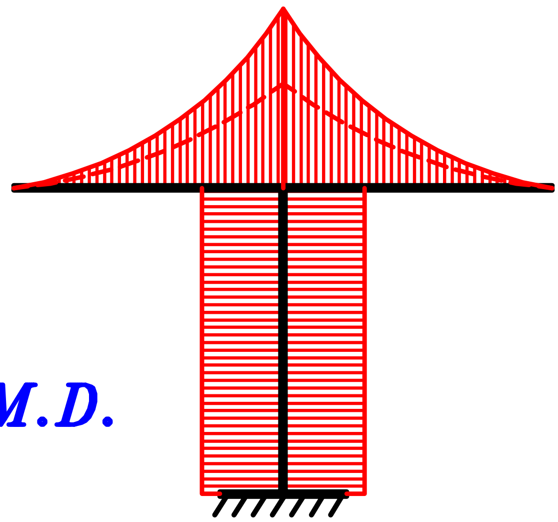
توجد ثلاث كمرات محمولين على ال **Frame**
البلاطات **one way** فى اتجاه الكمرات





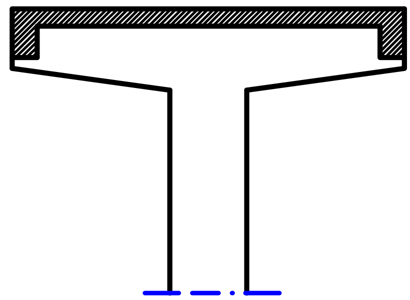


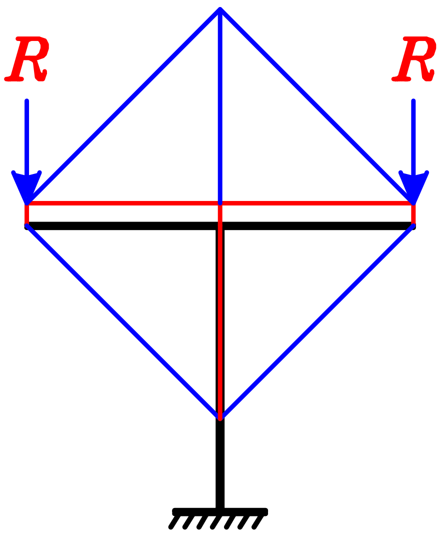


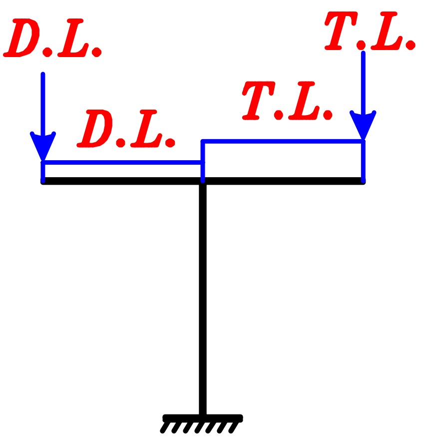


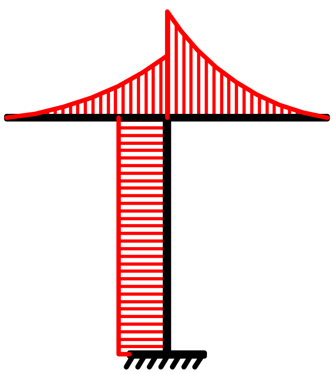
max−max B.M.D.

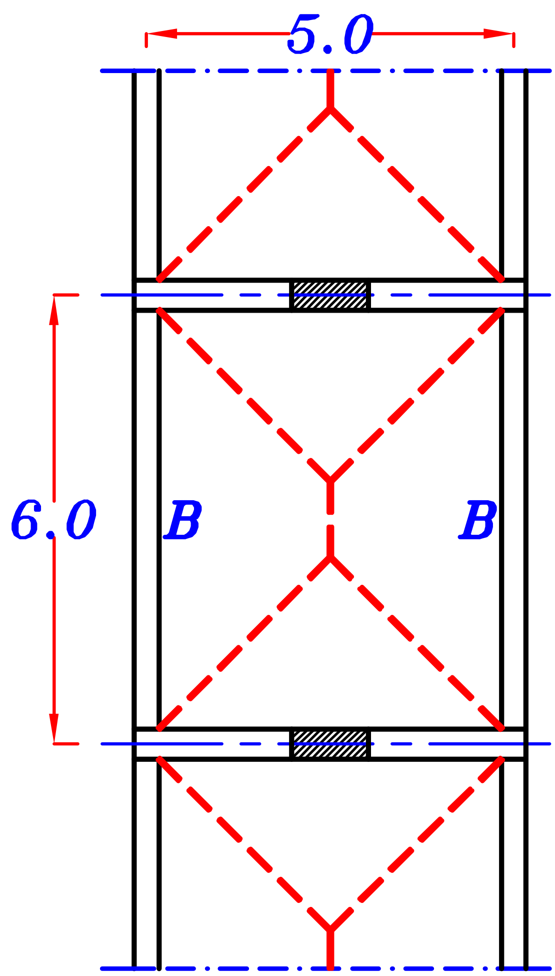
توجد كمرتان فقط محمولتان على ال **Frame**
البلاطات **Two way**

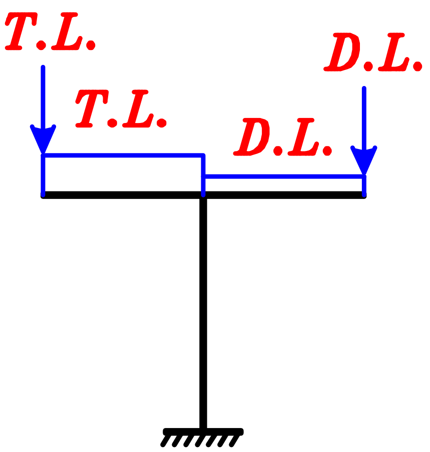


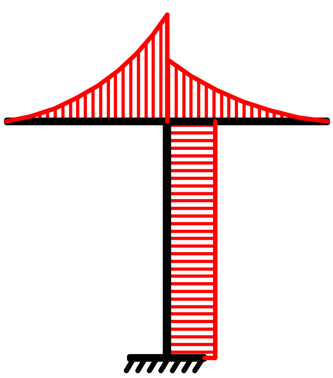


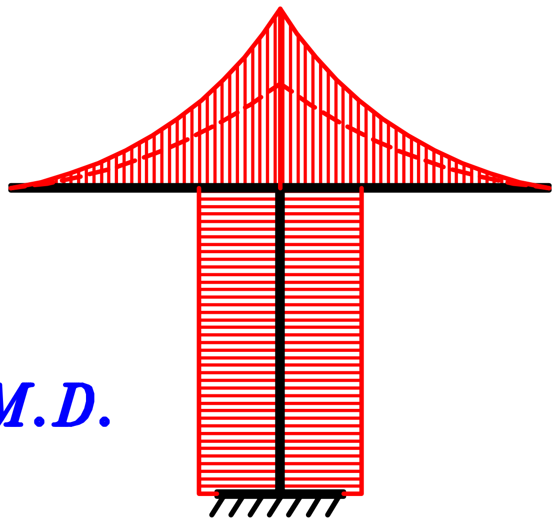






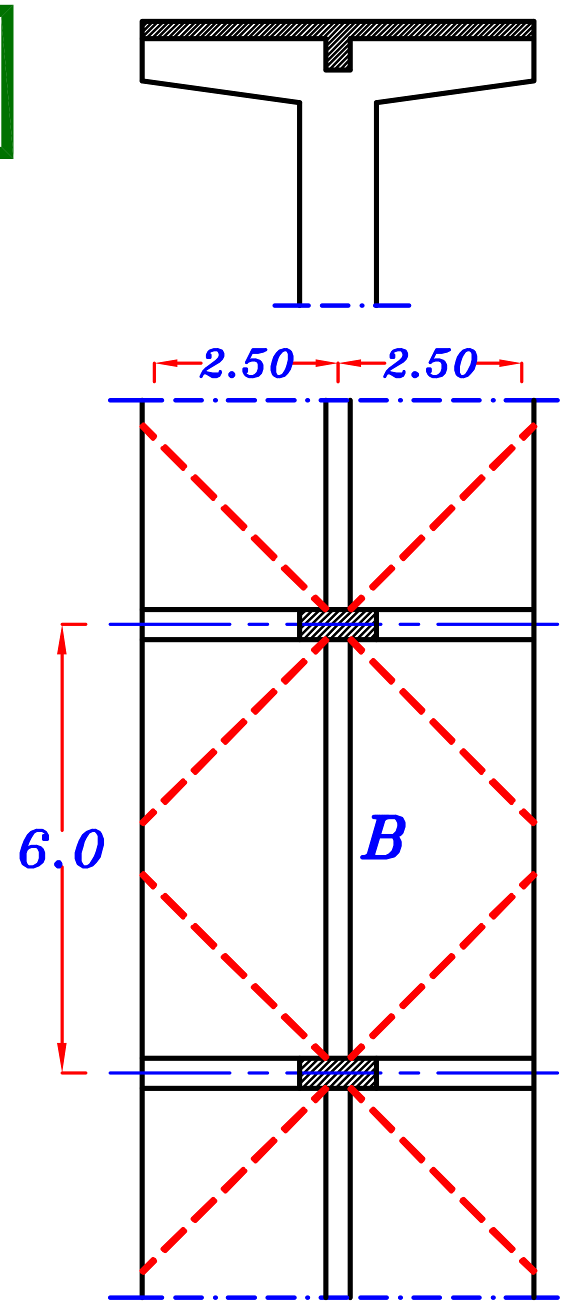


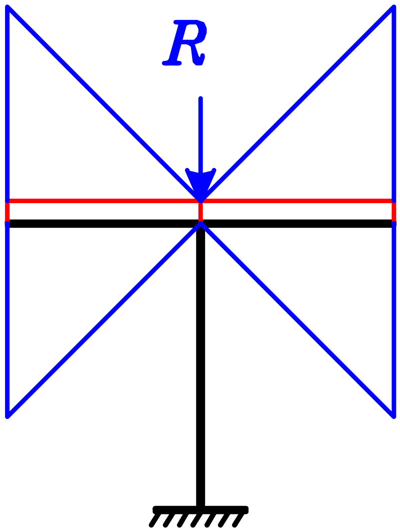


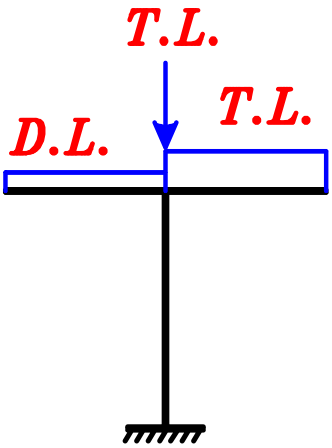


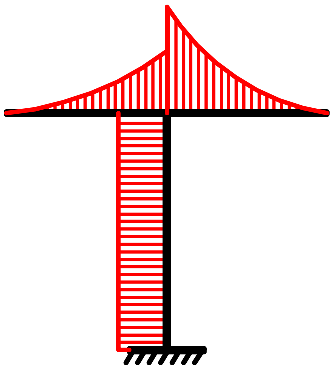
max−max B.M.D.

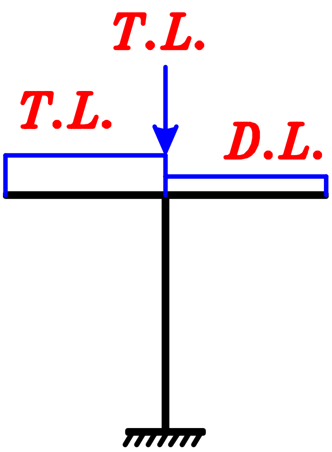
Frame توجد كمره واحده فقط محموله على ال
3 sided slab البلاطات

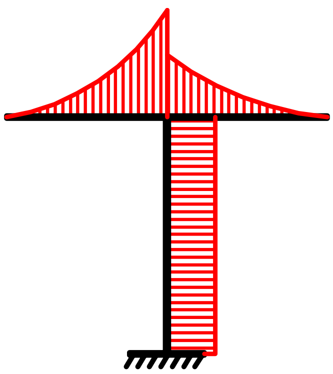


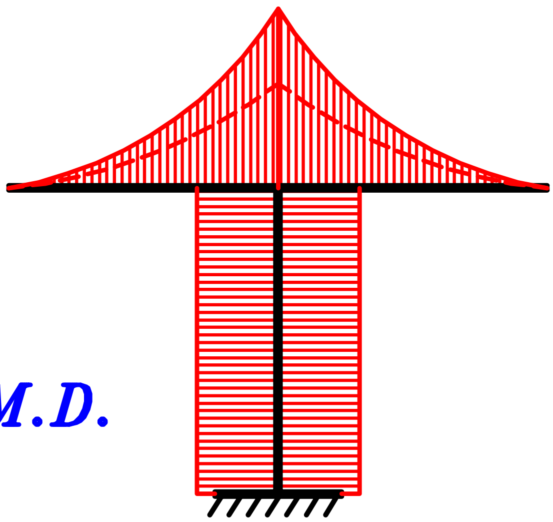






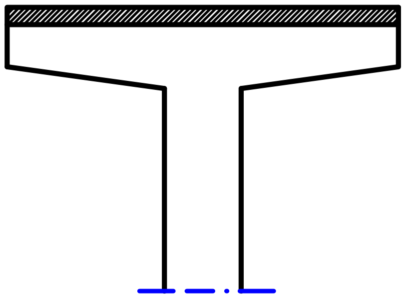


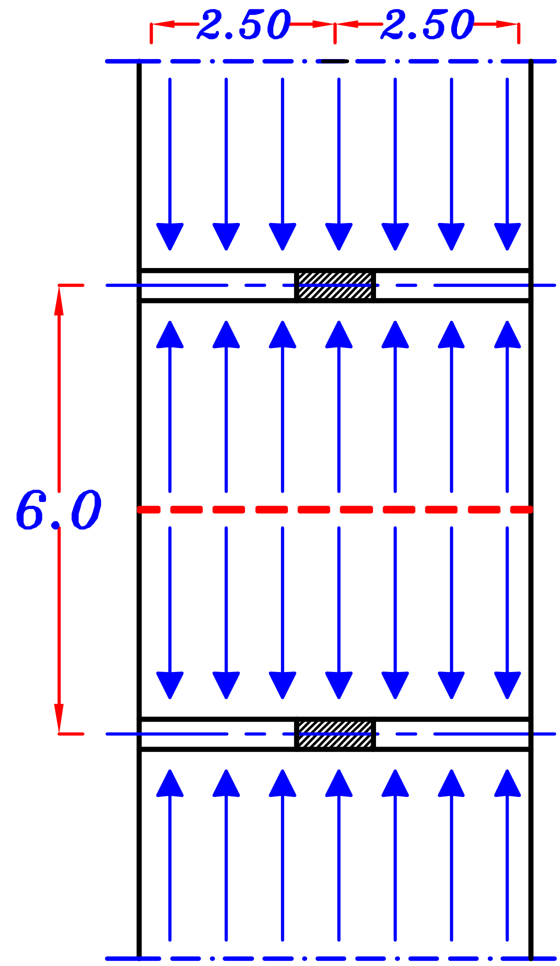


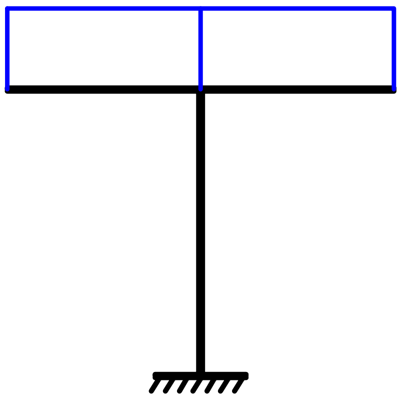


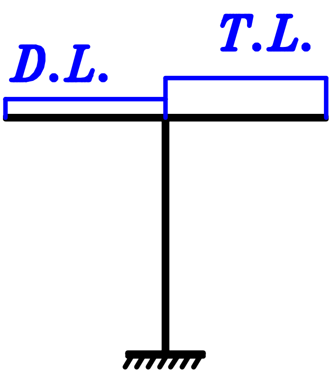
max–max B.M.D.

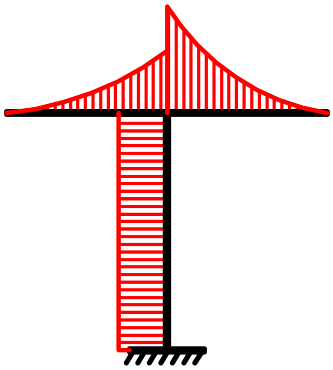
لا توجد كمرات محمولة على ال Frame
البلاطات one way فى اتجاه ال Frame

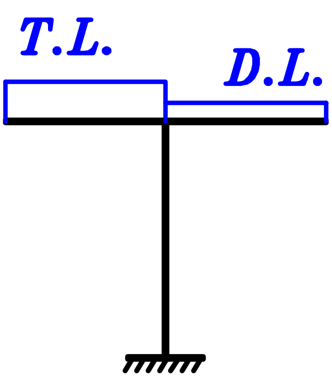


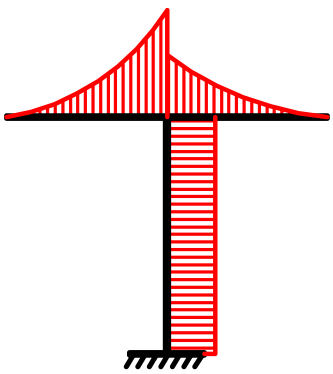


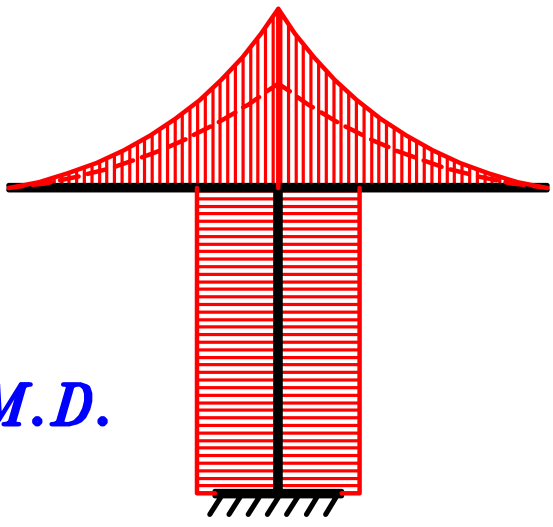












max−max B.M.D.

Example.

For the given Figure of structural plans, It is rquired to:

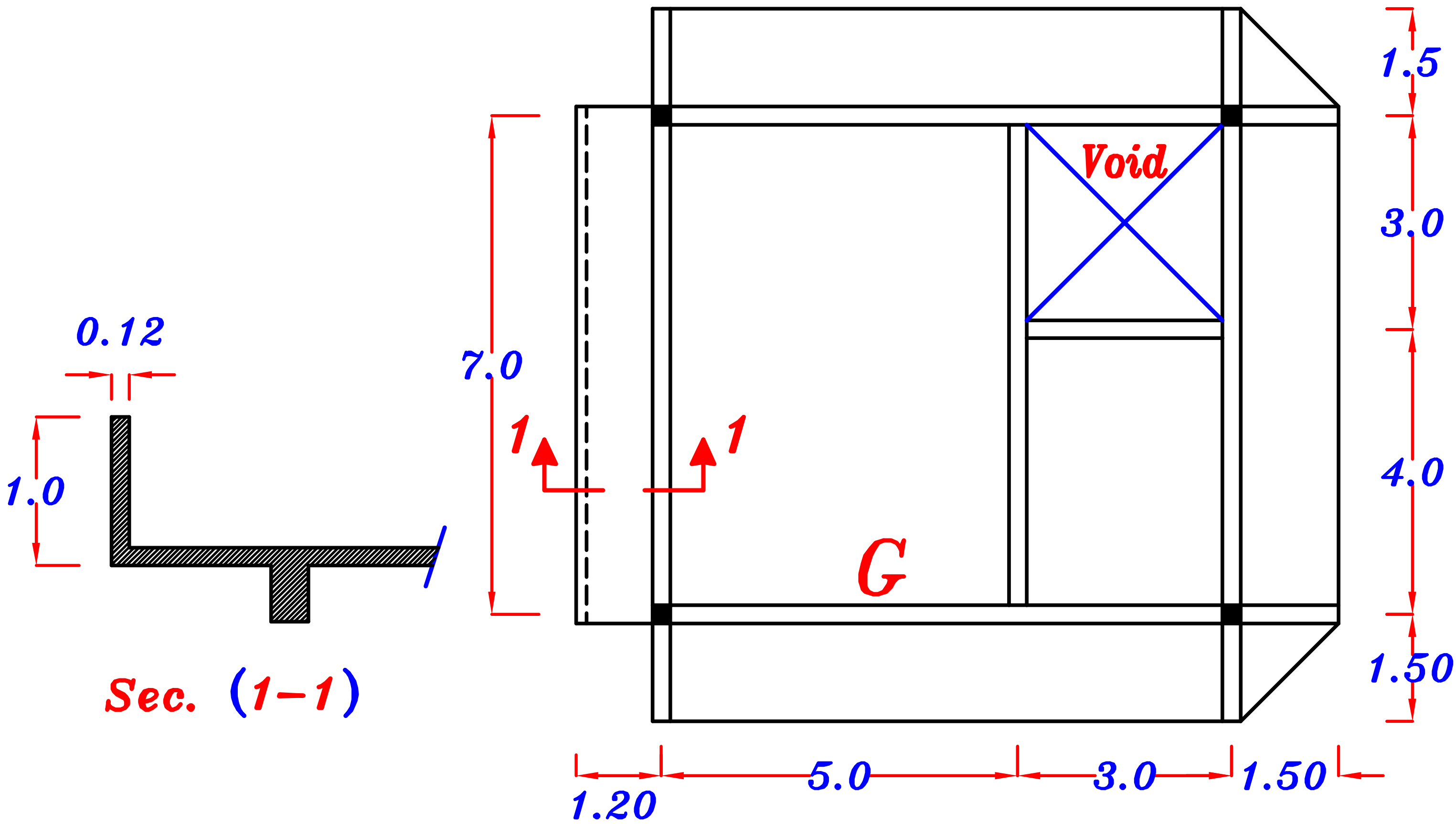
1- Draw a structural plan showing the shape of load distribution.

2- Calculate the equivalent loads For shear and bending For all Beams.

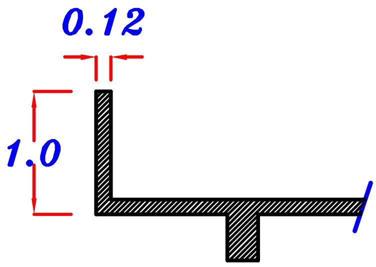
3- For girder marked (G), draw the S.F.D. and absolute (max-max) B.M.D.

$o.w._{beams} = 3.0\ kN\backslash m$ $o.w._{girder} = 6.0\ kN\backslash m$ $t_s = 0.12\ m$

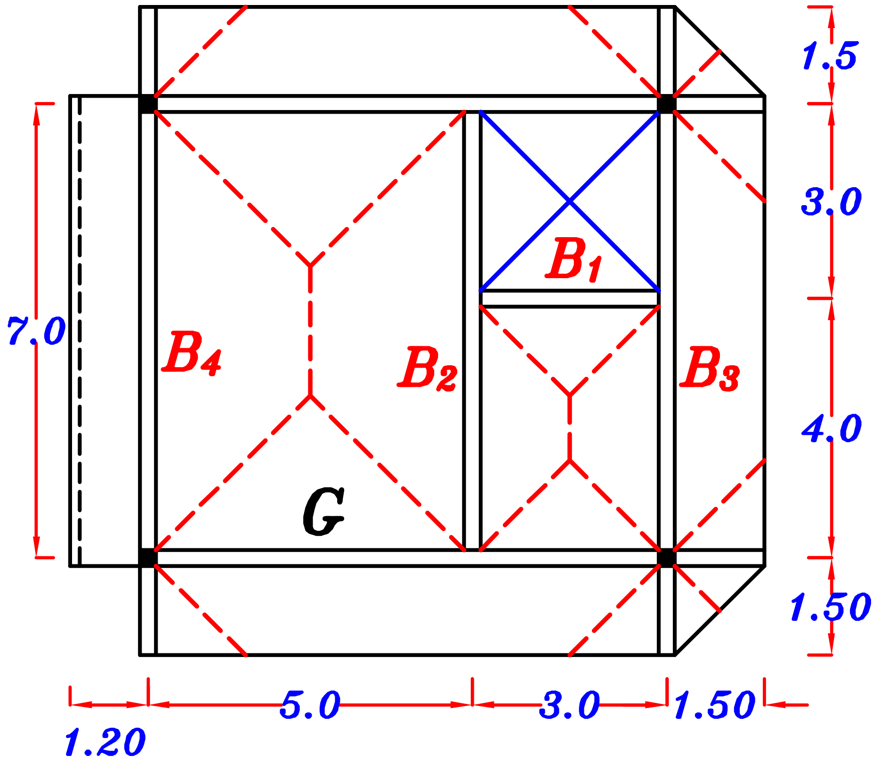
$F.C. = 1.5\ kN\backslash m^2$ $L.L. = 3.0\ kN\backslash m^2$



1- Draw a structural plan showing the shape of load distribution.



Sec. (1-1)



g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.5 = 4.50 \ kN\backslash m^2$$

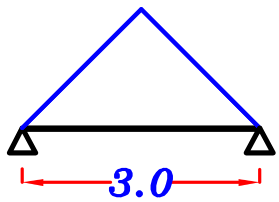
$$p_s = L.L. = 3.0 \ kN\backslash m^2$$

$\boxed{g_s = 4.50 \ kN\backslash m^2}$, $\boxed{p_s = 3.0 \ kN\backslash m^2}$

2- Calculate the equivalent working loads For shear and moment For beams B_1, B_2, B_3 & B_4.

B_1

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

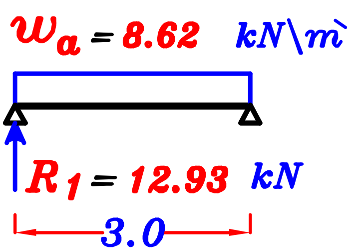


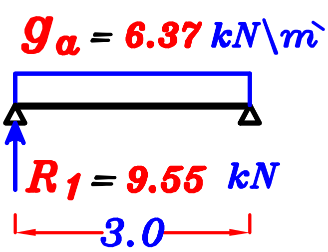
Load For Shear.

$$g_a = O.W. + C_a \ g_s \frac{L_s}{2} = 3.0 + \frac{1}{2}(4.50)\left(\frac{3.0}{2}\right) = 6.37 \ kN\backslash m$$

$$p_a = C_a \ p_s \frac{L_s}{2} = \frac{1}{2}(3.0)\left(\frac{3.0}{2}\right) = 2.25 \ kN\backslash m$$

$$w_a = g_a + p_a = 6.37 + 2.25 = 8.62 \ kN\backslash m$$





$$\boxed{\begin{aligned} R_1 &= 9.55 \ kN \text{ ---- D.L.} \\ &= 12.93 \ kN \text{ ---- T.L.} \end{aligned}}$$

Load For Moment.

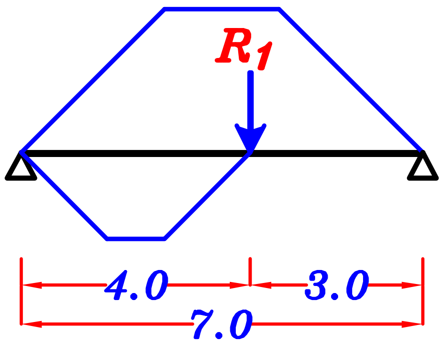
$$g_e = 0.W. + C_e\ g_s \frac{L_s}{2} = 3.0 + \frac{2}{3}(4.50)\left(\frac{3.0}{2}\right) = 7.50\ kN\backslash m$$

$$p_e = C_e\ p_s \frac{L_s}{2} = \frac{2}{3}(3.0)\left(\frac{3.0}{2}\right) = 3.0\ kN\backslash m$$

$$w_e = g_a + p_a = 7.50 + 3.0 = 10.50\ kN\backslash m$$

B_2

For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.0}{7.0}\right) = 0.64$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.0}{7.0}\right)^2 = 0.83$$

$$\frac{\sum area}{span} = \frac{\left(\frac{4+1}{2}\right)(1.5)}{7.0} = 0.53$$

Load For Shear.

$$g_a = o.w. + C_a\ g_s \frac{L_s}{2} + \frac{\sum area}{span} * g_s$$

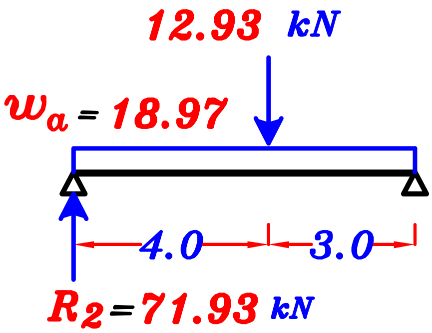
$$= 3.0 + (0.64)(4.50)\left(\frac{5.0}{2}\right) + (0.53)(4.50) = 12.58\ kN\backslash m$$

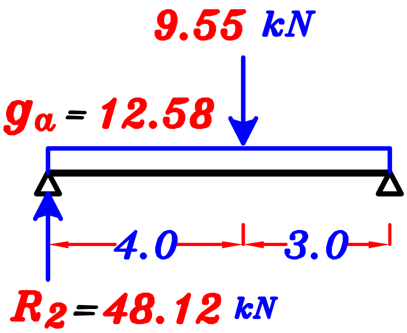
$$p_a = C_a\ p_s \frac{L_s}{2} + \frac{\sum area}{span} * p_s$$

$$= (0.64)(3.0)\left(\frac{5.0}{2}\right) + (0.53)(3.0) = 6.39\ kN\backslash m$$

$$w_a = g_a + p_a = 12.58 + 6.39 = 18.97\ kN\backslash m$$

$$\boxed{\begin{aligned} R_2 &= 48.12\ kN \text{---- D.L.} \\ &= 71.93\ kN \text{---- T.L.} \end{aligned}}$$





Load For Moment.

$$g_e = o.w. + C_e\, g_s \frac{L_s}{2} + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.83)(4.50)\left(\frac{5.0}{2}\right) + (0.53)(4.50) = 14.72 \; kN\backslash m'$$

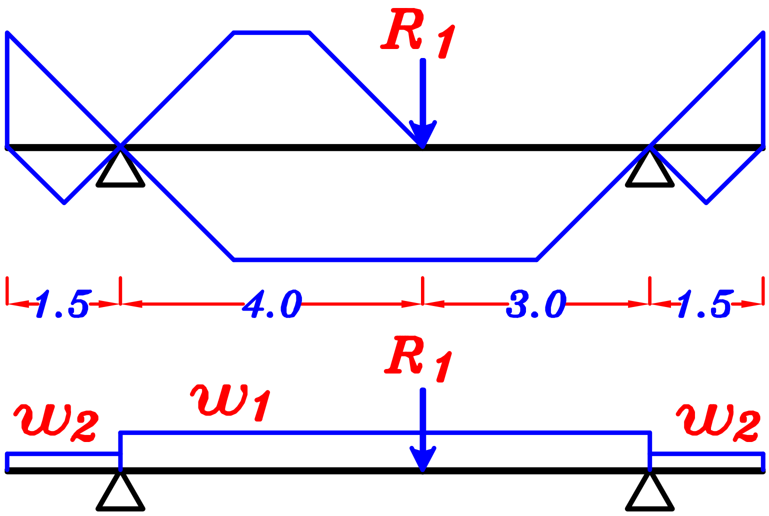
$$p_e = C_e\, p_s \frac{L_s}{2} + \frac{\sum area}{span} * p_s$$

$$= (0.83)(3.0)\left(\frac{5.0}{2}\right) + (0.53)(3.0) = 7.81 \; kN\backslash m'$$

$$w_e = g_e + p_e = 14.72 + 7.81 = 22.53 \; kN\backslash m'$$

B_3

w_1

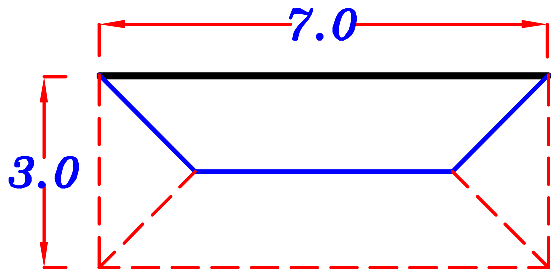


$$\frac{\sum area}{span} = \frac{\left(\frac{4+1}{2}\right)(1.5)}{7.0} = 0.53$$

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.0}{7.0}\right) = 0.78$$

$$C_e = 1 - \frac{1}{3}\left(\frac{2L_c}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.0}{7.0}\right)^2 = 0.94$$



Load For Shear.

$$g_{1a} = o.w. + C_a\, g_s\, L_c + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.78)(4.50)(1.5) + (0.53)(4.50) = 10.65 \; kN\backslash m'$$

$$p_{1a} = C_a\, p_s\, L_c + \frac{\sum area}{span} * p_s$$

$$= (0.78)(2.0)(1.5) + (0.53)(2.0) = 3.4 \; kN\backslash m'$$

$$w_{1a} = g_{1a} + p_{1a} = 10.65 + 3.4 = 14.05 \; kN\backslash m'$$

Load For Moment.

$$g_{1e} = o.w. + C_e \; g_s \, L_c + \frac{\sum area}{span} * g_s$$

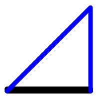
$$= 3.0 + (0.94)(4.50)(1.5) + (0.53)(4.50) = \mathbf{11.73} \; kN\backslash m`$$

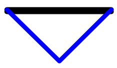
$$p_{1e} = C_e \; p_s \frac{L_s}{2} + \frac{\sum area}{span} * p_s$$

$$= (0.94)(2.0)\left(\frac{3.0}{2}\right) + (0.53)(2.0) = \mathbf{3.88} \; kN\backslash m`$$

$$w_{1e} = g_{1e} + p_{1e} = 11.73 + 3.88 = \mathbf{15.61} \; kN\backslash m`$$

$\underline{\underline{w2}}$

For Triangle  $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

For Triangle  $C_a = \frac{1}{2}$, $C_e = \frac{1}{2}$

Load For Shear.

$$g_{2a} = o.w. + C_a \; g_s \, L_c + C_a \; g_s \frac{L_c}{2}$$

$$= 3.0 + \left(\frac{1}{2}\right)(4.50)(1.5) + \left(\frac{1}{2}\right)(4.50)\left(\frac{1.5}{2}\right) = \mathbf{8.06} \; kN\backslash m`$$

$$p_{2a} = C_a \, p_s \, L_c + C_a \; p_s \frac{L_c}{2}$$

$$= \left(\frac{1}{2}\right)(2.0)(1.5) + \left(\frac{1}{2}\right)(2.0)\left(\frac{1.5}{2}\right) = \mathbf{2.25} \; kN\backslash m`$$

$$w_{2a} = g_{2a} + p_{2a} = 8.06 + 2.25 = \mathbf{10.31} \; kN\backslash m`$$

Load For Moment.

$$g_{2e} = o.w. + C_e \; g_s \, L_c + C_e \; g_s \frac{L_c}{2}$$

$$= 3.0 + \left(\frac{2}{3}\right)(4.50)(1.5) + \left(\frac{1}{2}\right)(4.50)\left(\frac{1.5}{2}\right) = \mathbf{9.18} \; kN\backslash m`$$

$$p_{2e} = C_e \, p_s \, L_c + C_e \; p_s \frac{L_c}{2}$$

$$= \left(\frac{2}{3}\right)(2.0)(1.5) + \left(\frac{1}{2}\right)(2.0)\left(\frac{1.5}{2}\right) = \mathbf{2.75} \; kN\backslash m`$$

$$w_{2e} = g_{2a} + p_{2a} = 9.18 + 2.75 = \mathbf{11.93} \; kN\backslash m`$$

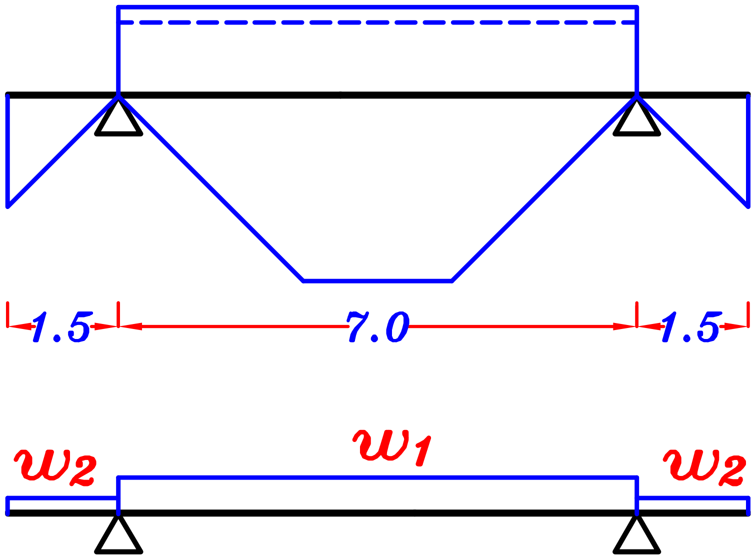
B_4

w_1

For Trapezoid

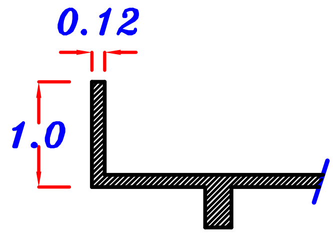
$C_a = 0.64$

$C_e = 0.83$



$$\text{Parapet weight} = b * h * \gamma_c$$

$$= 0.12 * 1.0 * 25 = 3.0 \ kN/m$$



Load For Shear.

$$g_{1a} = o.w. + C_a \, g_s \frac{L_s}{2} + g_s \, L_c + Parapet$$

$$= 3.0 + (0.64)(4.50)\left(\frac{5.0}{2}\right) + (4.5)\,(1.2) + 3.0 = 18.60 \ kN\backslash m'$$

$$p_{1a} = C_a \, p_s \frac{L_s}{2} + p_s \, L_c$$

$$= (0.64)(3.0)\left(\frac{5.0}{2}\right) + (3.0)\,(1.2) = 8.4 \ kN\backslash m'$$

$$w_{1a} = g_{1a} + p_{1a} = 18.60 + 8.4 = 27.0 \ kN\backslash m'$$

Load For Moment.

$$g_{1e} = o.w. + C_e \, g_s \frac{L_s}{2} + g_s \, L_c + Parapet$$

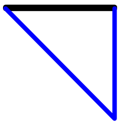
$$= 3.0 + (0.83)(4.50)\left(\frac{5.0}{2}\right) + (4.5)\,(1.2) + 3.0 = 20.73 \ kN\backslash m'$$

$$p_{1e} = C_e \, p_s \frac{L_s}{2} + p_s \, L_c$$

$$= (0.83)(3.0)\left(\frac{5.0}{2}\right) + (3.0)\,(1.2) = 9.82 \ kN\backslash m'$$

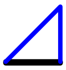
$$w_{1e} = g_{1e} + p_{1e} = 20.73 + 9.82 = 30.55 \ kN\backslash m'$$

$\underline{\underline{w2}}$ For Triangle



$C_a = \frac{1}{2}\ , \ C_e = \frac{2}{3}$

Load For Shear.



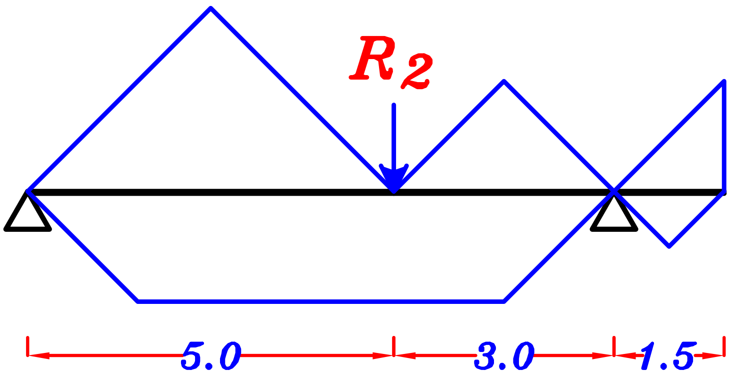
$g_{2a} = o.w. + C_a\ g_s\ L_c = 3.0 + (\frac{1}{2})(4.50)(1.5) = 6.37\ kN\backslash m`$

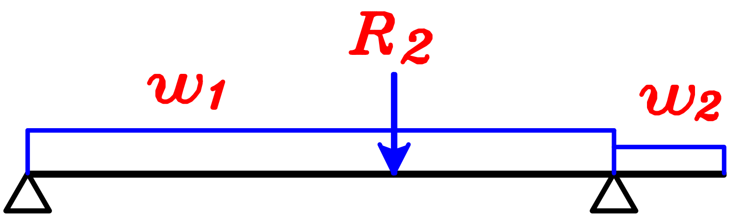
$p_{2a} = C_a\ p_s\ L_c = (\frac{1}{2})(2.0)(1.5) = 1.5\ kN\backslash m`$

$w_{2a} = g_{2a} + p_{2a} = 6.37 + 1.5 = 7.87\ kN\backslash m`$

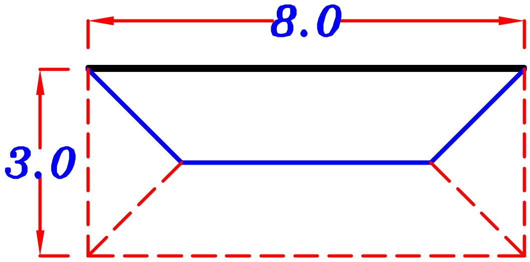
Loads on the girder $\underline{\underline{G}}$

$\underline{\underline{w1}}$



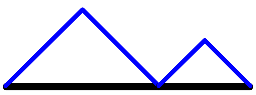


For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.0}{8.0}\right) = 0.81$$

$$C_e = 1 - \frac{1}{3}\left(\frac{2L_c}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.0}{8.0}\right)^2 = 0.95$$



$$\frac{\sum area}{span} = \frac{(\frac{1}{2})(5)(2.5) + (\frac{1}{2})(3)(1.5)}{8.0} = 1.062$$

Load For Shear.

$$g_{1a} = o.w. + C_a \, g_s \, L_c + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.81)(4.50)(1.5) + (1.062)(4.50) = 13.24 \ kN\backslash m'$$

$$p_{1a} = C_a \, p_s \, L_c + \frac{\sum area}{span} * p_s$$

$$= (0.81)(2.0)(1.5) + (1.062)(2.0) = 4.55 \ kN\backslash m'$$

$$w_{1a} = g_{1a} + p_{1a} = 13.24 + 4.55 = 17.79 \ kN\backslash m'$$

Load For Moment.

$$g_{1e} = o.w. + C_e \, g_s \, L_c + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.95)(4.50)(1.5) + (1.062)(4.50) = 14.19 \ kN\backslash m'$$

$$p_{1e} = C_e \, p_s \, L_c + \frac{\sum area}{span} * p_s$$

$$= (0.95)(2.0)(1.5) + (1.062)(2.0) = 4.97 \ kN\backslash m'$$

$$w_{1e} = g_{1e} + p_{1e} = 14.19 + 4.97 = 19.16 \ kN\backslash m'$$

w_2

For Triangle $\quad C_a = \frac{1}{2} \ , \ C_e = \frac{2}{3}$

For Triangle $\quad C_a = \frac{1}{2} \ , \ C_e = \frac{1}{2}$

Load For Shear.

$$g_{2a} = o.w. + C_a \, g_s \, L_c + C_a \, g_s \frac{L_c}{2}$$

$$= 3.0 + (\tfrac{1}{2})(4.50)(1.5) + (\tfrac{1}{2})(4.50)(\tfrac{1.5}{2}) = 8.06 \ kN\backslash m'$$

$$p_{2a} = C_a \, p_s \, L_c + C_a \, p_s \frac{L_c}{2}$$

$$= (\tfrac{1}{2})(2.0)(1.5) + (\tfrac{1}{2})(2.0)(\tfrac{1.5}{2}) = 2.25 \ kN\backslash m'$$

$$w_{2a} = g_{2a} + p_{2a} = 8.06 + 2.25 = 10.31 \ kN\backslash m'$$

Load For Moment.

$$g_{2e} = o.w. + C_e \, g_s \, L_c + C_e \, g_s \frac{L_c}{2}$$

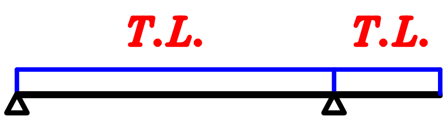
$$= 3.0 + (\tfrac{2}{3})(4.50)(1.5) + (\tfrac{1}{2})(4.50)(\tfrac{1.5}{2}) = 9.18 \ kN\backslash m'$$

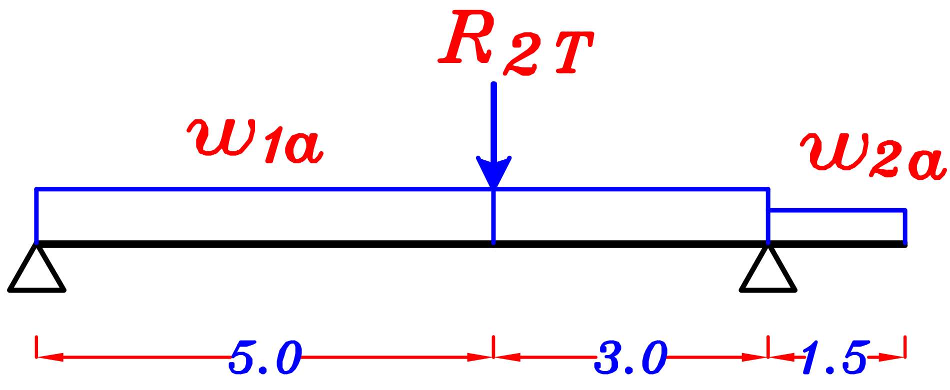
$$p_{2e} = C_e \, p_s \, L_c + C_e \, p_s \frac{L_c}{2}$$

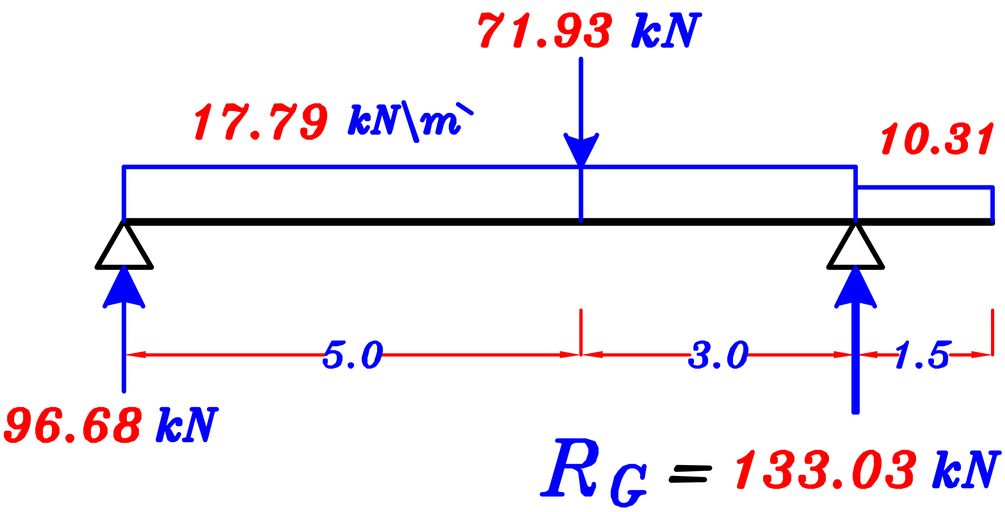
$$= (\tfrac{2}{3})(2.0)(1.5) + (\tfrac{1}{2})(2.0)(\tfrac{1.5}{2}) = 2.75 \ kN\backslash m'$$

$$w_{2e} = g_{2a} + p_{2a} = 9.18 + 2.75 = 11.93 \ kN\backslash m'$$

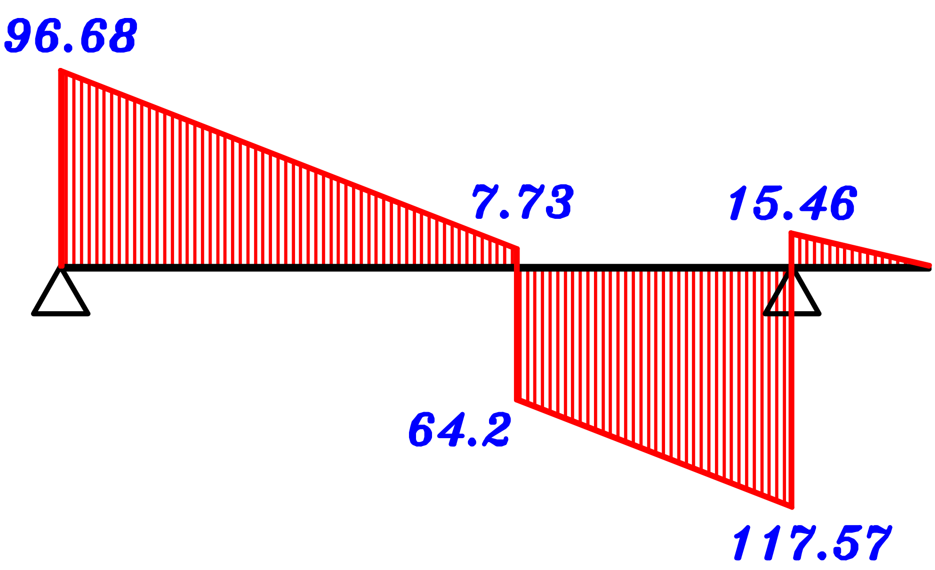
Draw the S.F.D.



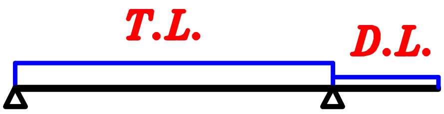


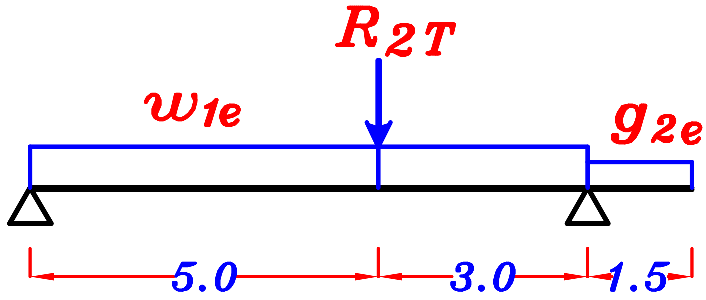


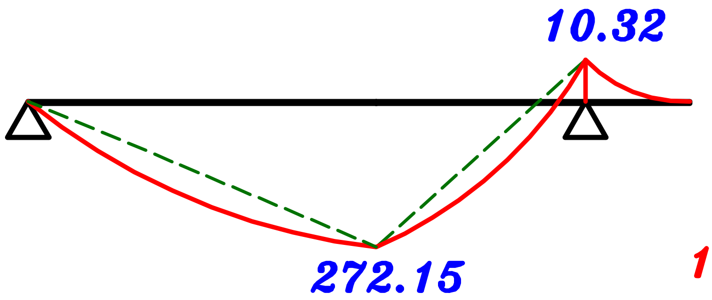
S.F.D.

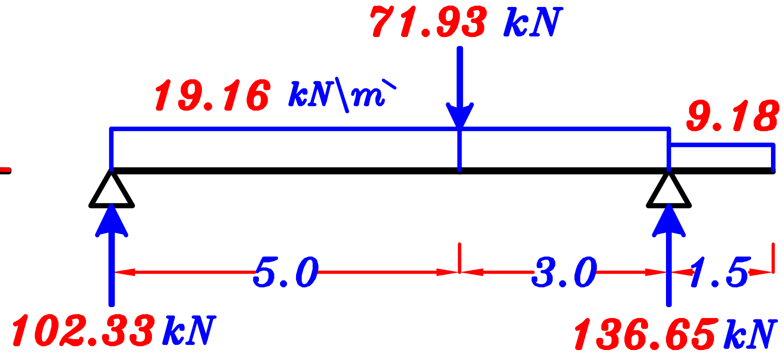


1- max. +ve B.M.D.

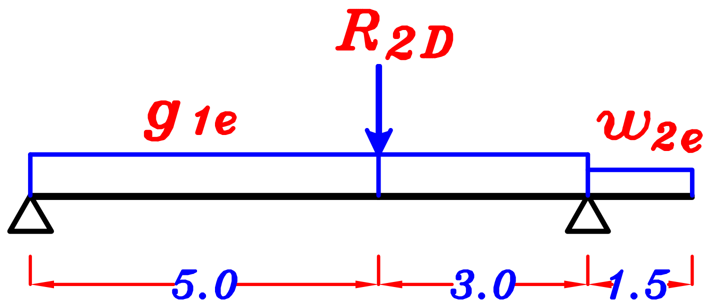


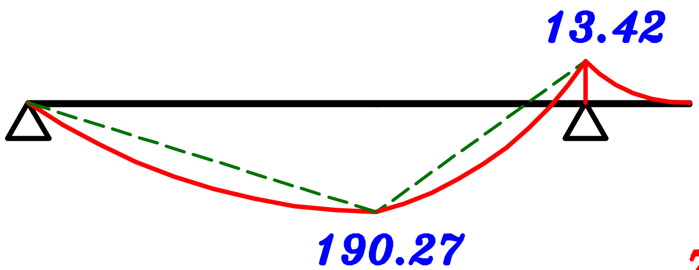


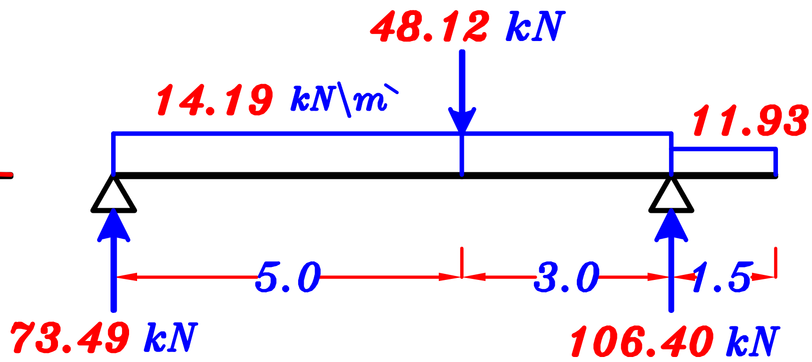




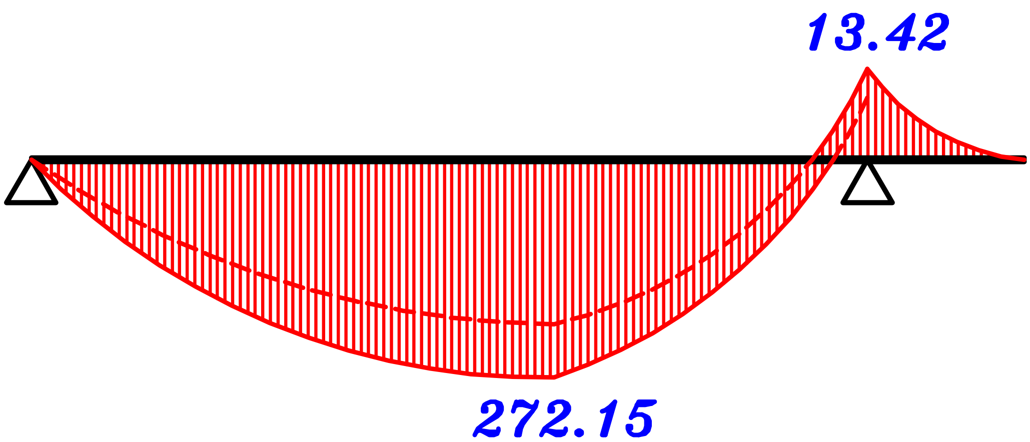
2- max. -ve B.M.D.







max.-max. B.M.D.



Example.

Data:

Slab thickness = 140 mm , F.C. = 3.0 kN/m^2 , L.L. = 1.0 kN/m^2

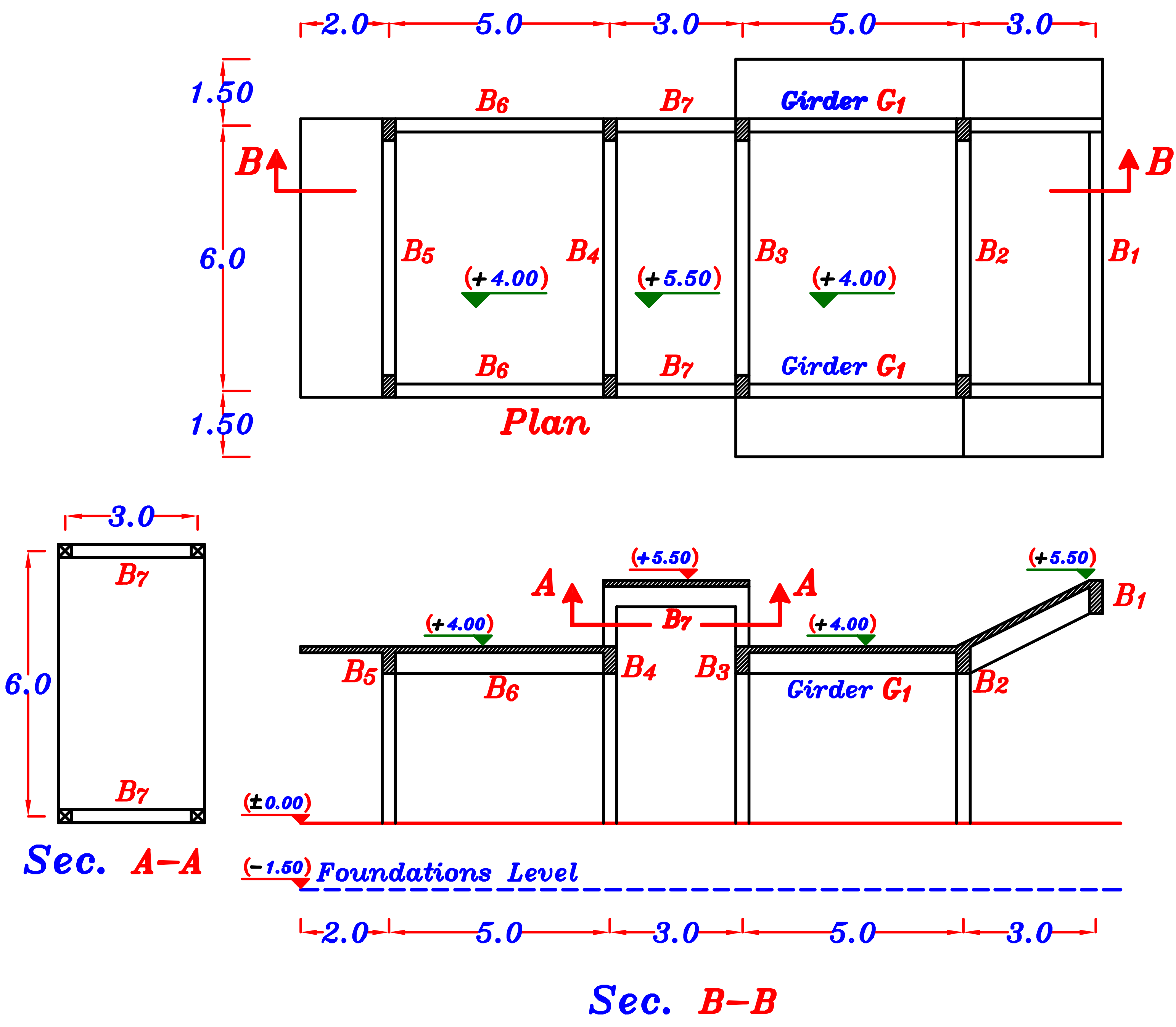
For the shown reinforced concrete building in the Figure It is required to :

1 – Draw to scale 1:50 a structural plan and section showing concrete dimensions of all structural elements.

2 – Carry out load distribution For all beams at levels +4.00 and +5.50

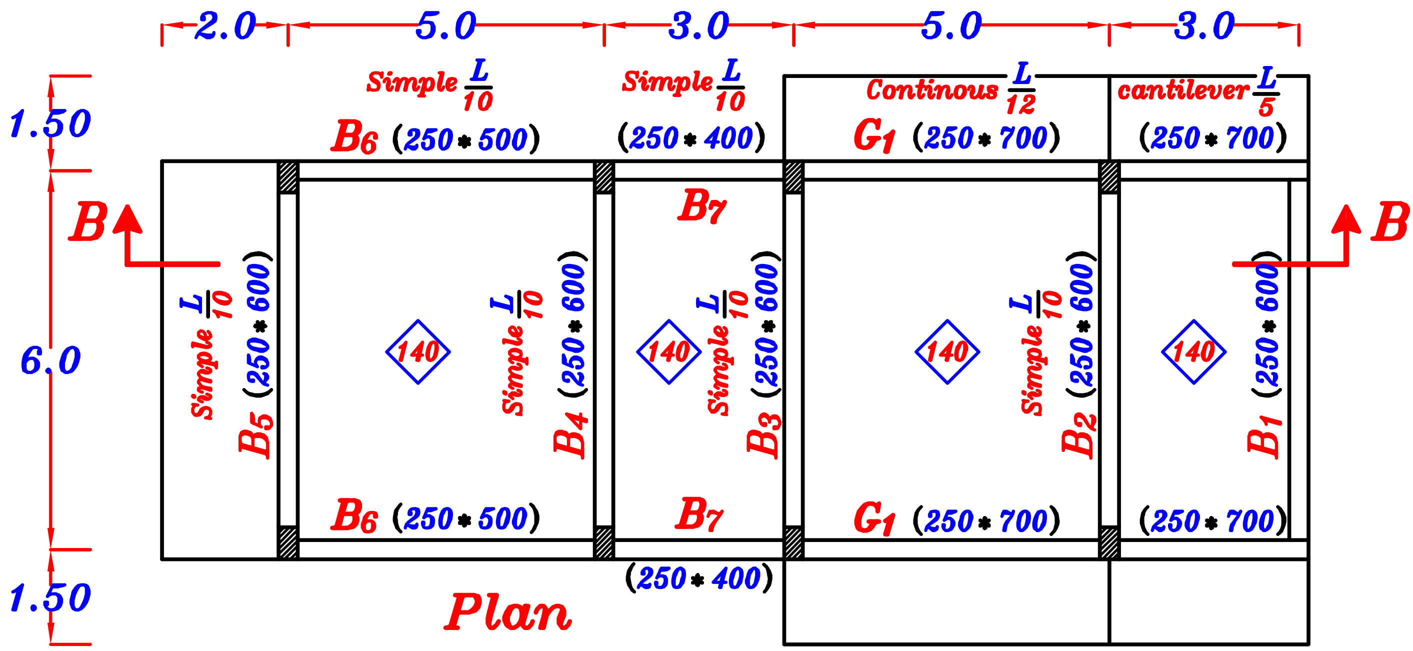
3 – Calculate the loads For bending and shear For all beams and girder (G_1).

4 – Draw the absolute B.M.D. and S.F.D. For the girder (G_1).

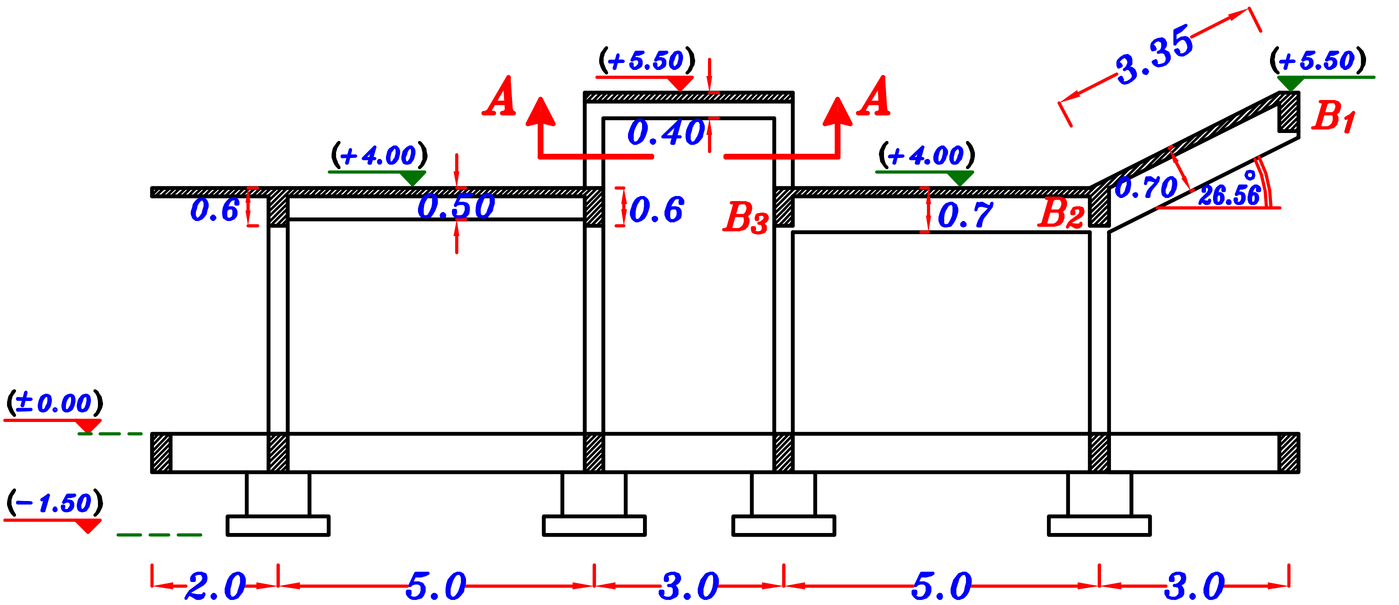


Solution.

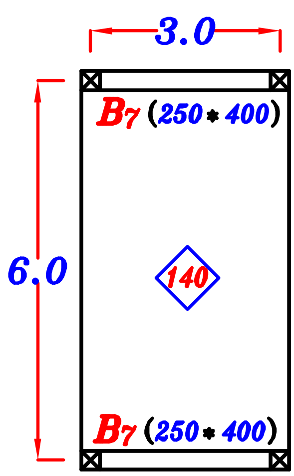
1 – Draw to scale 1:50 a structural plan and section showing concrete dimensions of all structural elements.



Plan

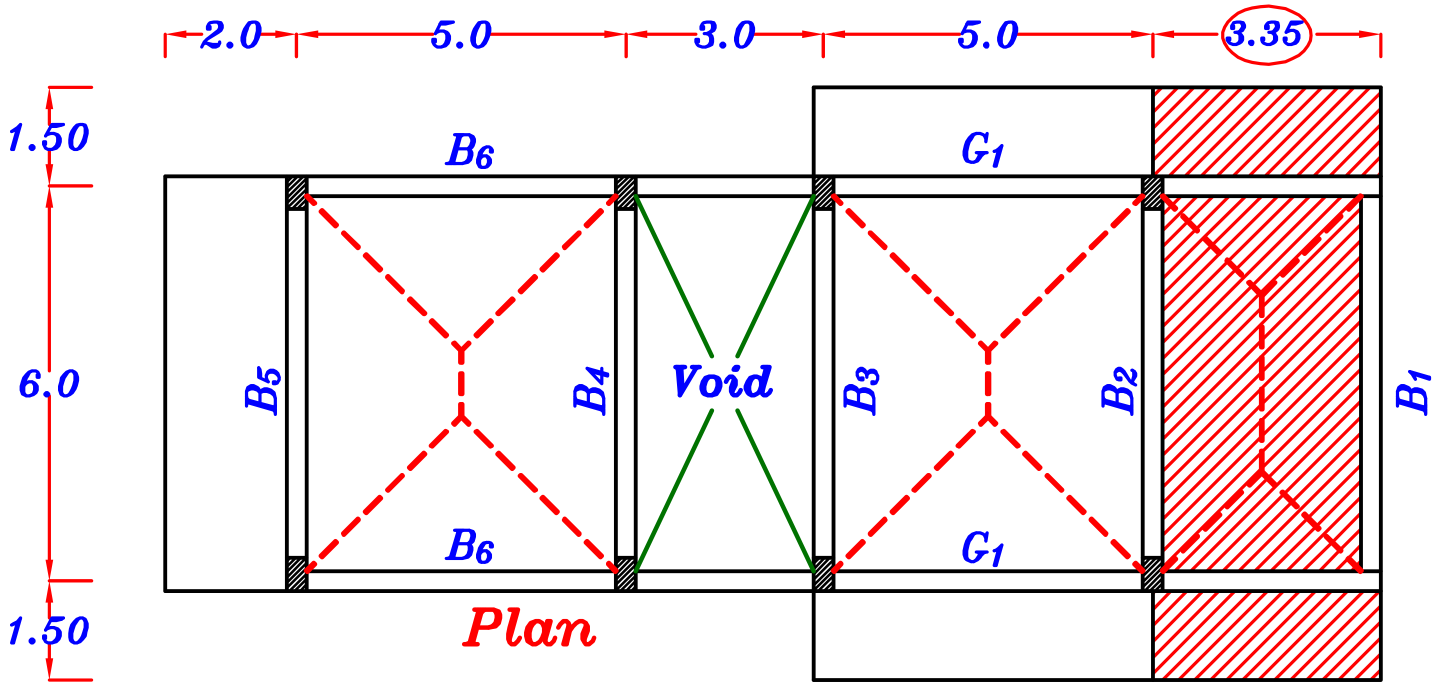


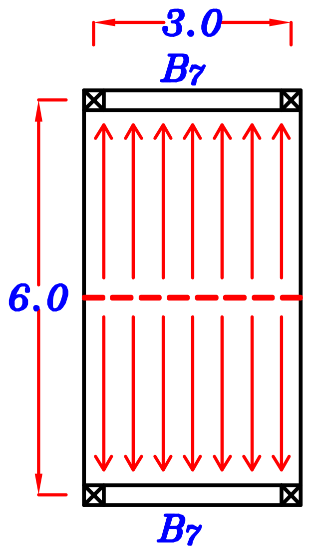
Sec. B–B



Sec. A–A

2- Carry out load distribution For all beams at levels +4.00 and +5.50





Sec. A-A

3- Calculate the loads For bending and shear For all beams and girder (G_1).

g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 3.0 = 6.5 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 1.0 \ kN\backslash m^2$$

$$p_{si} = L.L. * \cos\theta = 1.0 \ \cos 26.56 = 0.89 \ kN\backslash m^2$$

$\boxed{g_s = 6.5 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 0.89 \ kN\backslash m^2}$

o.w. of Beams & Frames $= b\ t\ \delta_c$

Beams (250*400) o.w. $= (0.25)(0.4)(25) = 2.50$ kN\m`

Beams (250*500) o.w. $= (0.25)(0.5)(25) = 3.12$ kN\m`

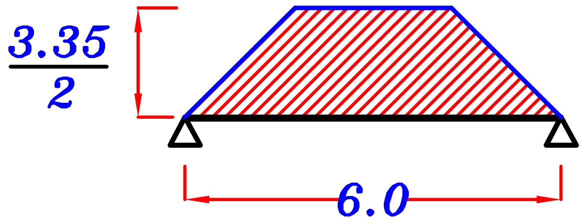
Beams (250*600) o.w. $= (0.25)(0.6)(25) = 3.75$ kN\m`

Girder (250*700) o.w. $= (0.25)(0.7)(25) = 4.37$ kN\m`

B_1 (250*600) $\longrightarrow$ o.w. $= 3.75$ kN\m`

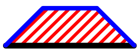
For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.35}{6.0}\right) = 0.72$$



$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.35}{6.0}\right)^2 = 0.89$$

Load For Shear.

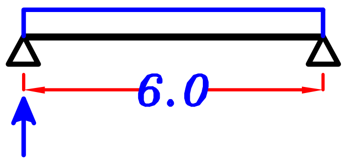


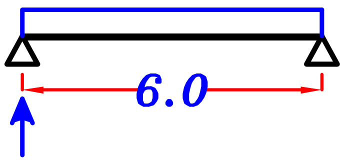
$$g_a = O.W. + C_a\ g_s\ \frac{L_s}{2} = 3.75 + (0.72)(6.5)\left(\frac{3.35}{2}\right) = 11.59 \text{ kN\m`}$$

$$p_a = C_a\ p_{si}\ \frac{L_s}{2} = (0.72)(0.89)\left(\frac{3.35}{2}\right) = 1.07 \text{ kN\m`}$$

$$w_a = g_a + p_a = 11.59 + 1.07 = 12.66 \text{ kN\m`}$$

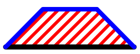
$w_a = 12.66$ kN\m` $g_a = 11.59$ kN\m`





$\boxed{R_{1T} = 37.98 \text{ kN}}$ $\boxed{R_{1D} = 34.77 \text{ kN}}$

Load For Moment.



$$g_e = O.W. + C_e\ g_s\ \frac{L_s}{2} = 3.75 + (0.89)(6.5)\left(\frac{3.35}{2}\right) = 13.44 \text{ kN\m`}$$

$$p_e = C_e\ p_{si}\ \frac{L_s}{2} = (0.89)(0.89)\left(\frac{3.35}{2}\right) = 1.32 \text{ kN\m`}$$

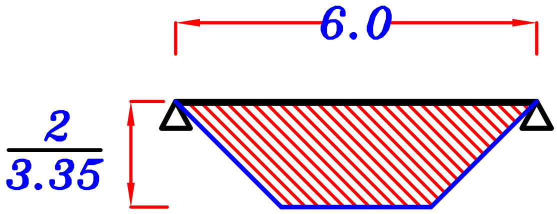
$$w_e = g_e + p_e = 13.44 + 1.32 = 14.76 \text{ kN\m`}$$

$\underline{\underline{B_2}}$ $(250*600) \longrightarrow o.w. = 3.75 \ kN\backslash m'$

For Trapezoid 1

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.35}{6.0}\right) = 0.72$$

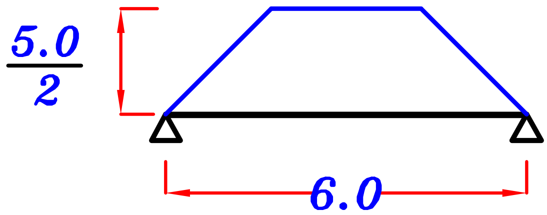
$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.35}{6.0}\right)^2 = 0.89$$



For Trapezoid 2

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.0}{6.0}\right) = 0.58$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.0}{6.0}\right)^2 = 0.77$$



Load For Shear.

$$g_a = 0.W. + C_{a1}\, g_s \frac{L_s}{2} + C_{a2}\, g_s \frac{L_s}{2}$$

$$= 3.75 + (0.72)(6.5)\left(\frac{3.35}{2}\right) + (0.58)(6.5)\left(\frac{5.0}{2}\right) = 21.0 \ kN\backslash m'$$

$$p_a = C_{a1}\, p_{si} \frac{L_s}{2} + C_{a2}\, p_{sh} \frac{L_s}{2} =$$

$$= (0.72)(0.89)\left(\frac{3.35}{2}\right) + (0.58)(1.0)\left(\frac{5.0}{2}\right) = 2.52 \ kN\backslash m'$$

$$w_a = g_a + p_a = 21.0 + 2.52 = 23.52 \ kN\backslash m'$$

Load For Moment.

$$g_e = 0.W. + C_{e1}\, g_s \frac{L_s}{2} + C_{a2}\, g_s \frac{L_s}{2}$$

$$= 3.75 + (0.89)(6.5)\left(\frac{3.35}{2}\right) + (0.77)(6.5)\left(\frac{5.0}{2}\right) = 25.95 \ kN\backslash m'$$

$$p_e = C_{e1}\, p_{si} \frac{L_s}{2} + C_{a2}\, p_{sh} \frac{L_s}{2} =$$

$$= (0.89)(0.89)\left(\frac{3.35}{2}\right) + (0.77)(1.0)\left(\frac{5.0}{2}\right) = 3.25 \ kN\backslash m'$$

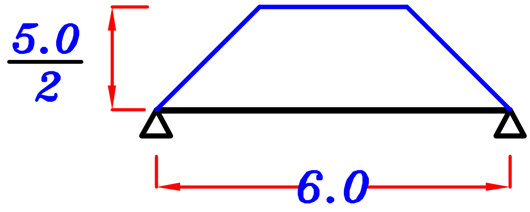
$$w_e = g_e + p_e = 25.95 + 3.25 = 29.20 \ kN\backslash m'$$

B_3 & B_4 (250*600) $\longrightarrow$ o.w. = 3.75 kN\m`

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.0}{6.0}\right) = 0.58$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.0}{6.0}\right)^2 = 0.77$$



Load For Shear.

$$g_a = 0.W. + C_a\ g_s\ \frac{L_s}{2} = 3.75 + (0.58)(6.5)\left(\frac{5.0}{2}\right) = 13.17\ kN\backslash m`$$

$$p_a = C_a\ p_{sh}\ \frac{L_s}{2} = (0.58)(1.0)\left(\frac{5.0}{2}\right) = 1.45\ kN\backslash m`$$

$$w_a = g_a + p_a = 13.17 + 1.45 = 14.62\ kN\backslash m`$$

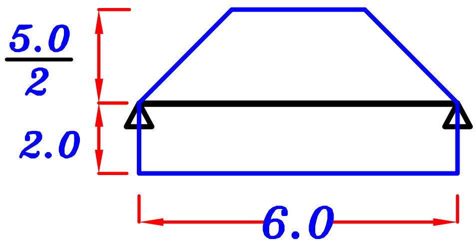
Load For Moment.

$$g_e = 0.W. + C_e\ g_s\ \frac{L_s}{2} = 3.75 + (0.77)(6.5)\left(\frac{5.0}{2}\right) = 16.26\ kN\backslash m`$$

$$p_e = C_e\ p_{sh}\ \frac{L_s}{2} = (0.77)(1.0)\left(\frac{5.0}{2}\right) = 1.92\ kN\backslash m`$$

$$w_e = g_e + p_e = 16.26 + 1.92 = 18.18\ kN\backslash m`$$

B_5 (250*600) $\longrightarrow$ o.w. = 3.75 kN\m`



For Trapezoid $C_a = 0.58$, $C_e = 0.77$

Load For Shear.

$$g_a = 0.W. + C_a\ g_s\ \frac{L_s}{2} + g_s\ L_c = 3.75 + (0.58)(6.5)\left(\frac{5.0}{2}\right) + (6.5)(2.0) = 26.17\ kN\backslash m`$$

$$p_a = C_a\ p_{sh}\ \frac{L_s}{2} + p_s\ L_c = (0.58)(1.0)\left(\frac{5.0}{2}\right) + (1.0)(2.0) = 3.45\ kN\backslash m`$$

$$w_a = g_a + p_a = 26.17 + 3.45 = 29.62\ kN\backslash m`$$

Load For Moment.

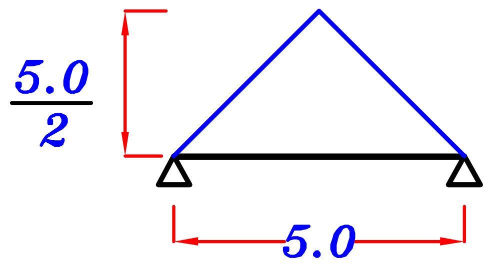
$$g_e = 0.W. + C_e\ g_s\ \frac{L_s}{2} + g_s\ L_c = 3.75 + (0.77)(6.5)\left(\frac{5.0}{2}\right) + (6.5)(2.0) = 29.26\ kN\backslash m`$$

$$p_e = C_e\ p_{sh}\ \frac{L_s}{2} + p_s\ L_c = (0.77)(1.0)\left(\frac{5.0}{2}\right) + (1.0)(2.0) = 3.92\ kN\backslash m`$$

$$w_e = g_e + p_e = 29.26 + 3.92 = 33.18\ kN\backslash m`$$

B_6 $(250 * 500) \longrightarrow o.w. = 3.12 \ kN\backslash m'$

For Triangle $C_a = \frac{1}{2}$ $C_e = \frac{2}{3}$



Load For Shear.

$$g_a = O.W. + C_a \ g_s \frac{L_s}{2} = 3.12 + \left(\frac{1}{2}\right)(6.5)\left(\frac{5.0}{2}\right) = 11.24 \ kN\backslash m'$$

$$p_a = C_a \ p_{sh} \frac{L_s}{2} = \left(\frac{1}{2}\right)(1.0)\left(\frac{5.0}{2}\right) = 1.25 \ kN\backslash m'$$

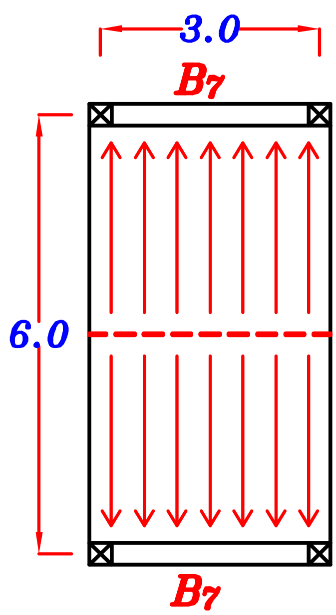
$$w_a = g_a + p_a = 11.24 + 1.25 = 12.49 \ kN\backslash m'$$

Load For Moment.

$$g_e = O.W. + C_e \ g_s \frac{L_s}{2} = 3.12 + \left(\frac{2}{3}\right)(6.5)\left(\frac{5.0}{2}\right) = 13.95 \ kN\backslash m'$$

$$p_e = C_e \ p_{sh} \frac{L_s}{2} = \left(\frac{2}{3}\right)(1.0)\left(\frac{5.0}{2}\right) = 1.67 \ kN\backslash m'$$

$$w_e = g_e + p_e = 13.95 + 1.67 = 15.62 \ kN\backslash m'$$



B_7 $(250 * 400) \longrightarrow o.w. = 2.50 \ kN\backslash m'$

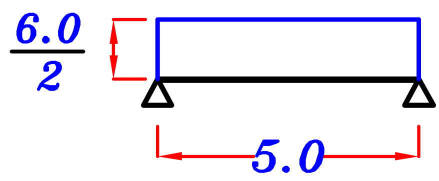
Load For Shear. = Load For Moment.

$$g_a = g_e = O.W. + g_s \frac{L_s}{2}$$

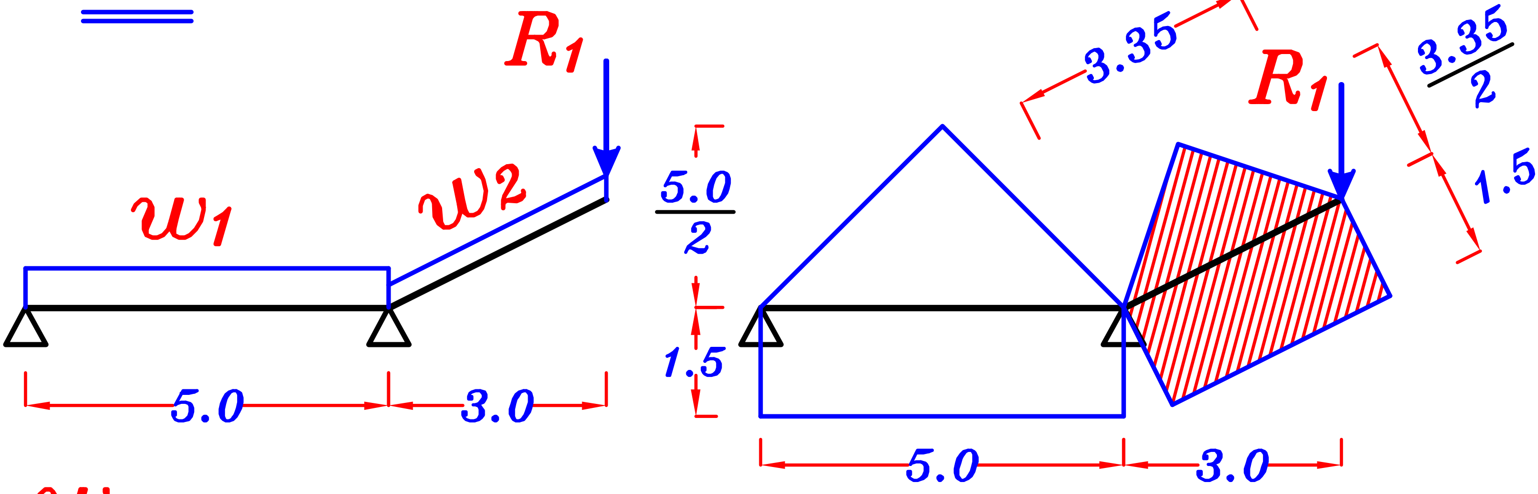
$$= 2.50 + (6.5)\left(\frac{6.0}{2}\right) = 22.0 \ kN\backslash m'$$

$$p_a = p_e = p_{sh} \frac{L_s}{2} = (1.0)\left(\frac{6.0}{2}\right) = 3.0 \ kN\backslash m'$$

$$w_a = g_a + p_a = 22.0 + 3.0 = 25.0 \ kN\backslash m'$$



G_1 (250*700) → o.w. = 4.37 kN\m`



W_1 For triangle $C_a = \frac{1}{2}$ $C_e = \frac{2}{3}$

Load For Shear.

$$g_{1a} = o.w. + C_a\, g_s \frac{L_s}{2} + g_s\, L_c = 4.37 + (\tfrac{1}{2})(6.5)(\tfrac{5.0}{2}) + (6.5)(1.5) = 22.25 \text{ kN\m`}$$

$$p_{1a} = C_a\, p_{sh} \frac{L_s}{2} + p_{sh}\, L_c = (\tfrac{1}{2})(1.0)(\tfrac{5.0}{2}) + (1.0)(1.5) = 2.75 \text{ kN\m`}$$

$$w_{1a} = g_{1a} + p_{1a} = 22.25 + 2.75 = 25.0 \text{ kN\m`}$$

Load For Moment.

$$g_{1e} = o.w. + C_e\, g_s \frac{L_s}{2} + g_s\, L_c = 4.37 + (\tfrac{2}{3})(6.5)(\tfrac{5.0}{2}) + (6.5)(1.5) = 24.95 \text{ kN\m`}$$

$$p_{1e} = C_e\, p_{sh} \frac{L_s}{2} + p_{sh}\, L_c = (\tfrac{2}{3})(1.0)(\tfrac{5.0}{2}) + (1.0)(1.5) = 3.16 \text{ kN\m`}$$

$$w_{1e} = g_{1e} + p_{1e} = 24.95 + 3.16 = 28.11 \text{ kN\m`}$$

W_2 For triangle $C_a = \frac{1}{2}$ $C_e = \frac{1}{2}$

Load For Shear. = Load For Moment.

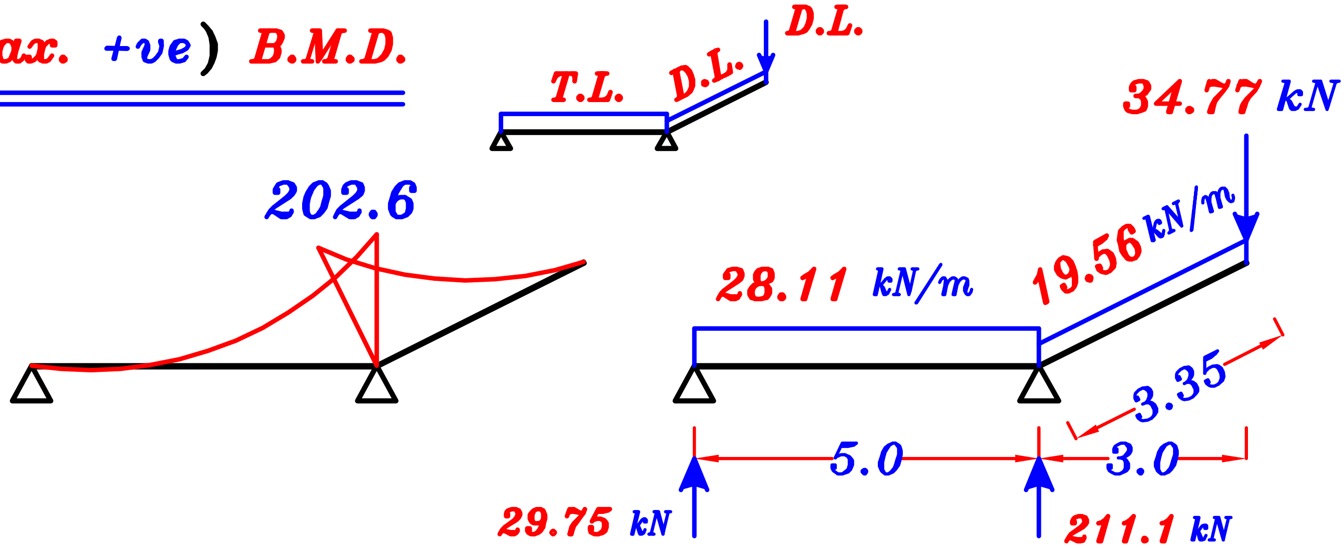
$$g_{2a} = g_{2e} = o.w. + C_a\, g_s \frac{L_c}{2} + g_s\, L_c = 4.37 + (\tfrac{1}{2})(6.5)(\tfrac{3.35}{2}) + (6.5)(1.5) = 19.56 \text{ kN\m`}$$

$$p_{2a} = p_{2e} = C_a\, p_{si} \frac{L_c}{2} + p_{si}\, L_c = (\tfrac{1}{2})(0.89)(\tfrac{3.35}{2}) + (0.89)(1.5) = 2.08 \text{ kN\m`}$$

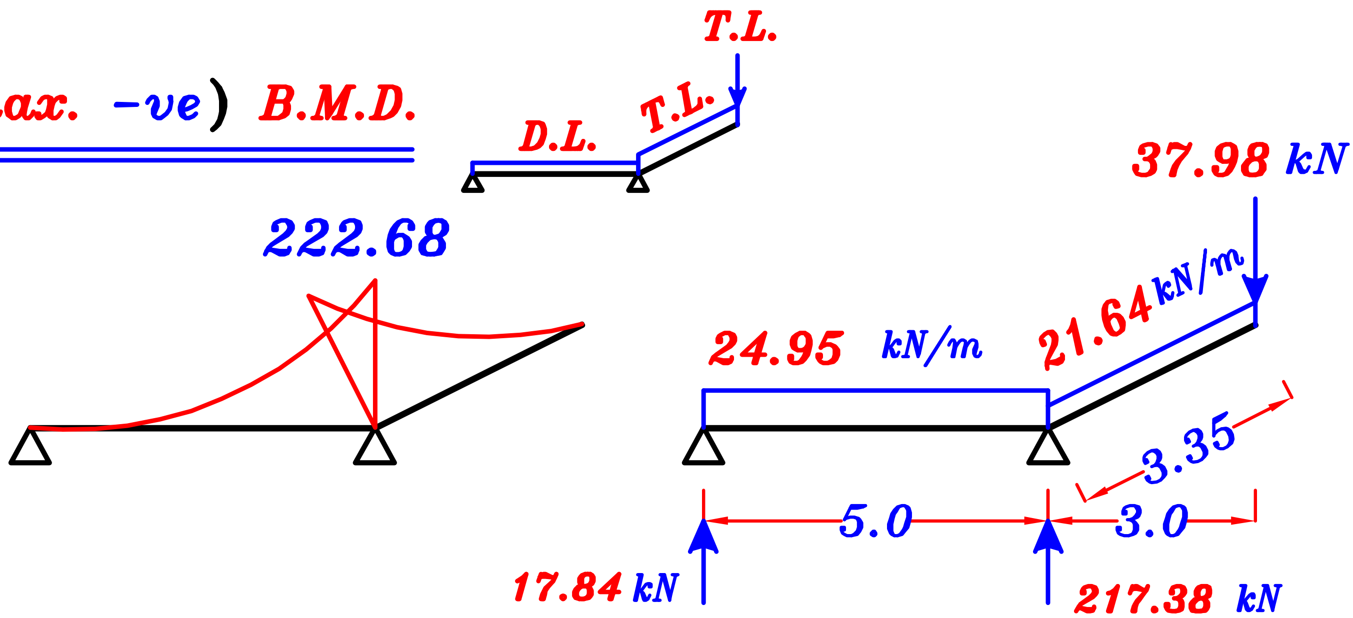
$$w_{2a} = w_{2e} = g_{2a} + p_{2a} = 19.56 + 2.08 = 21.64 \text{ kN\m`}$$

4- Draw the absolute B.M.D. and S.F.D. For the girder (G_1).

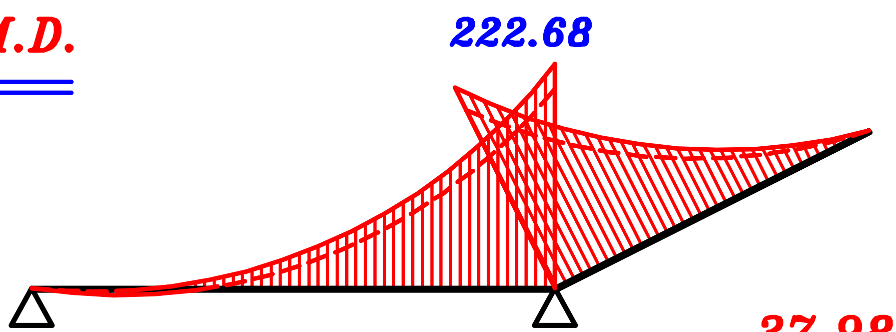
(max. +ve) B.M.D.



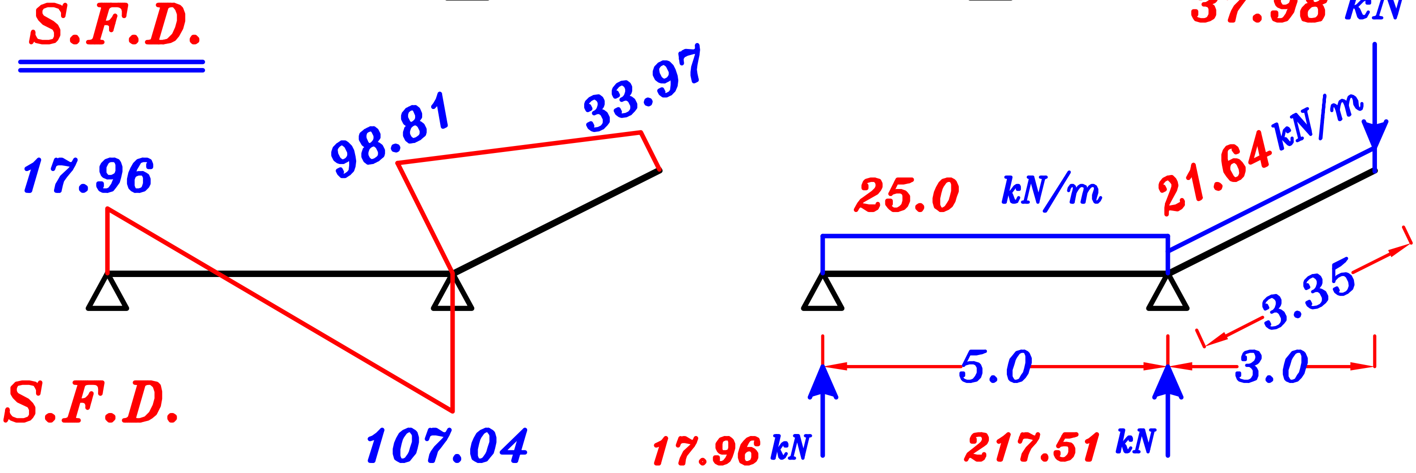
(max. -ve) B.M.D.



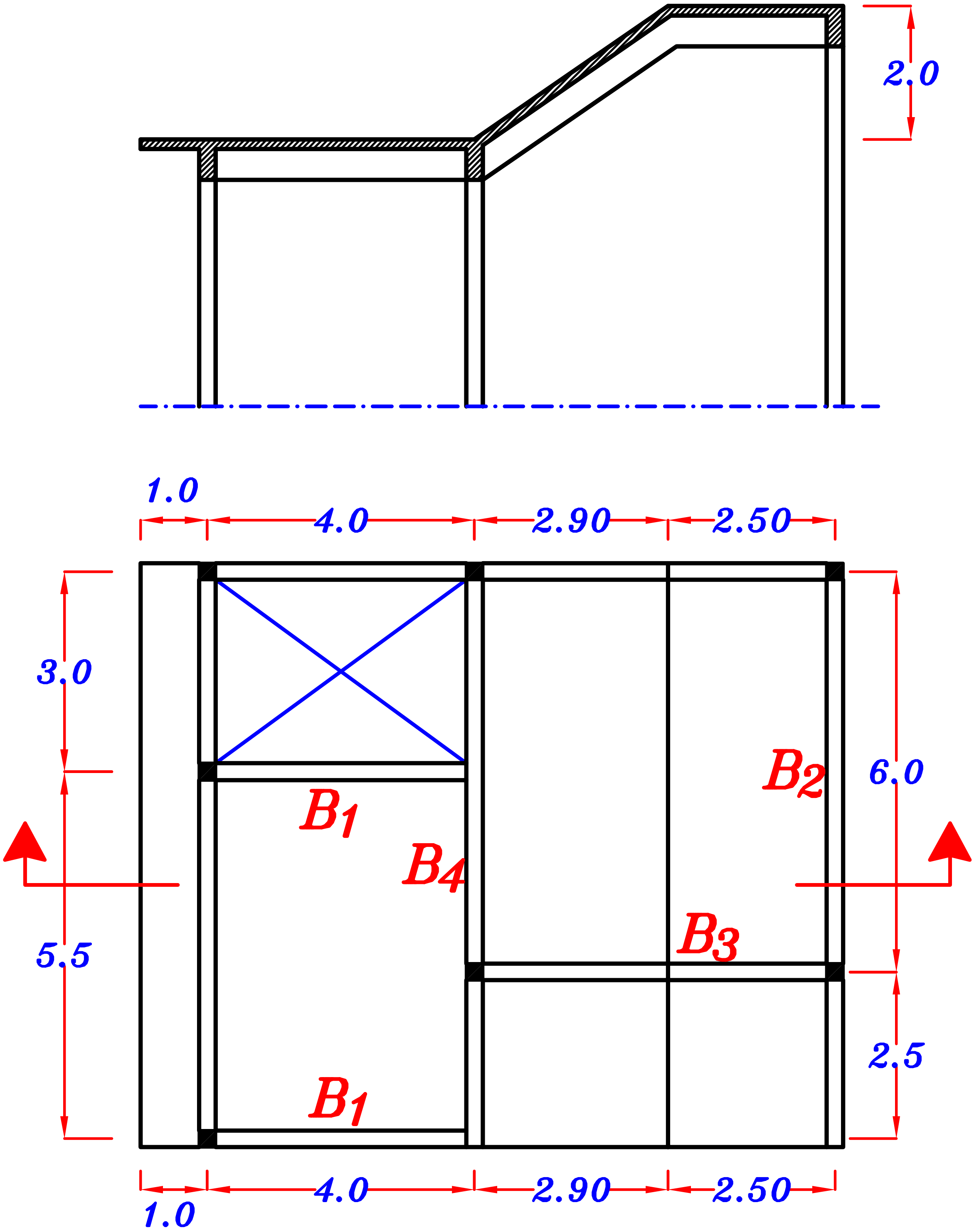
(max-max) B.M.D.



S.F.D.



Example.

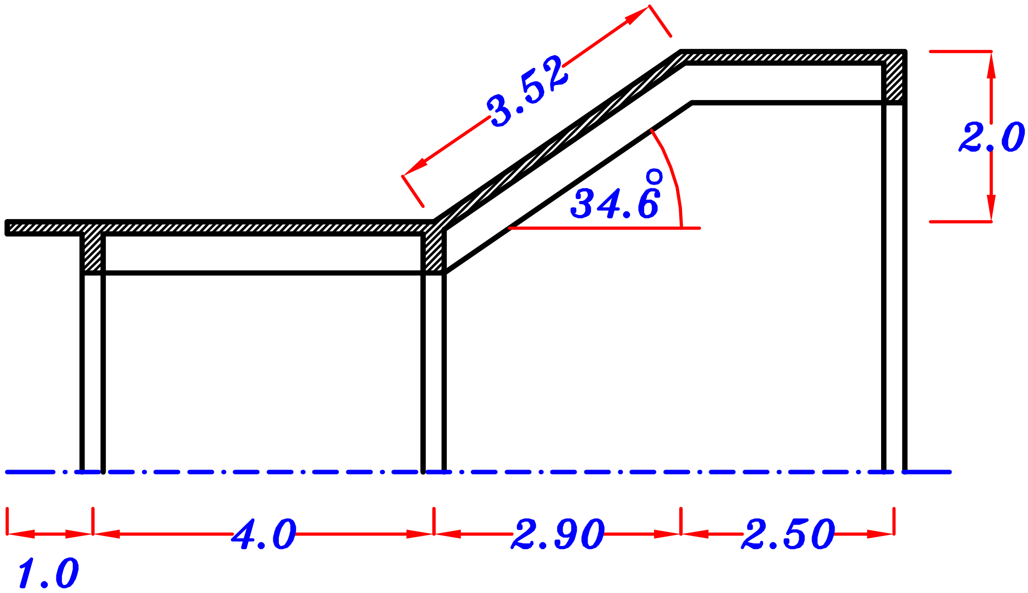


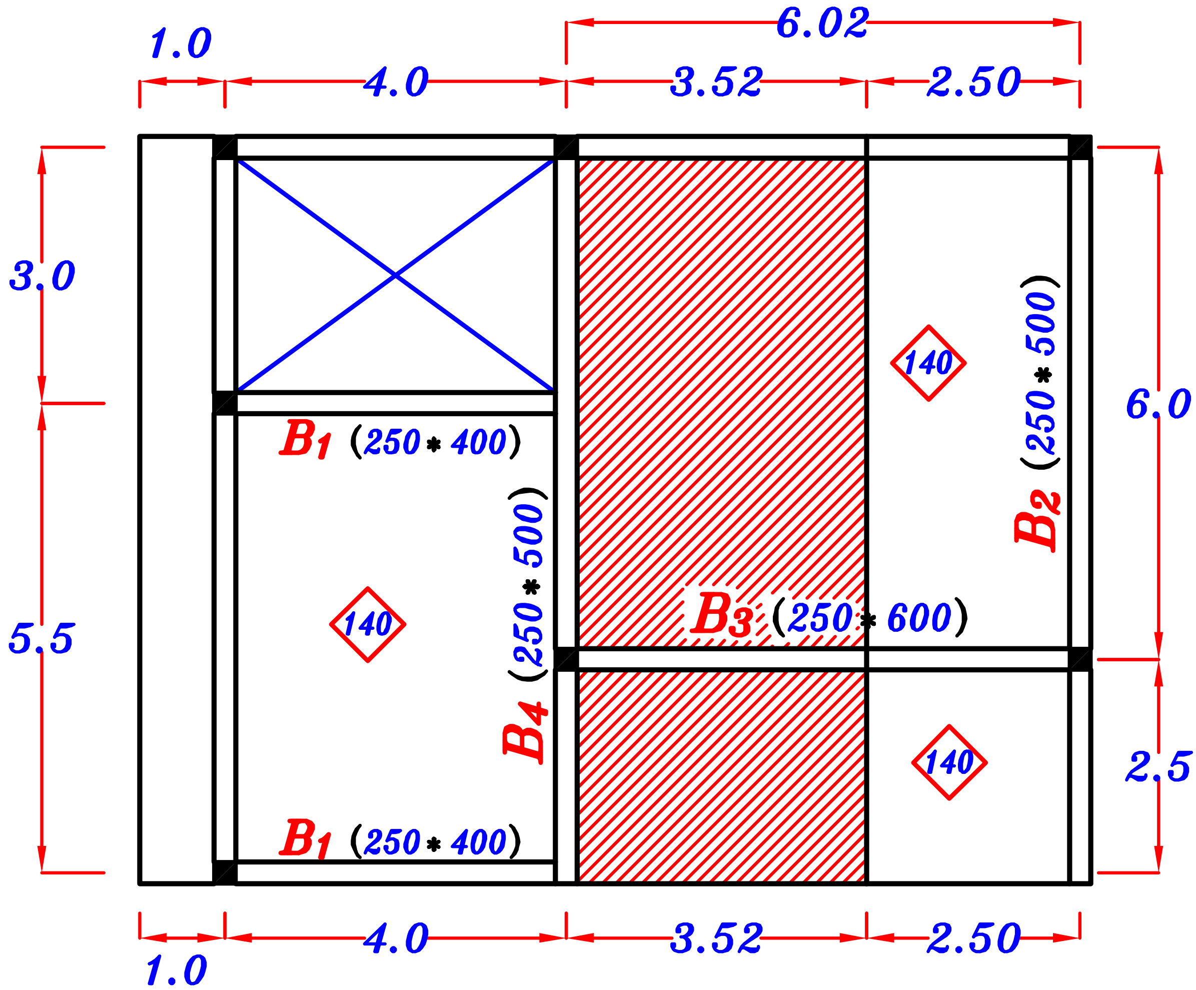
Data:

- Slab thickness $t_s = 140$ mm
- Live load = 2.0 $kN\backslash m^2$ HL. projection.
- Floor cover = 1.50 $kN\backslash m^2$

Required:

Draw max–max B.M.D. For Beams (B_2 , B_3 & B_4)





$$o.w. \text{ of Beams \& Frames} = b\ t\ \gamma_c$$

Beams (250*400) $o.w. = (0.25)(0.4)(25) = 2.50$ kN\m̀

Beams (250*500) $o.w. = (0.25)(0.5)(25) = 3.12$ kN\m̀

Beams (250*600) $o.w. = (0.25)(0.6)(25) = 3.75$ kN\m̀

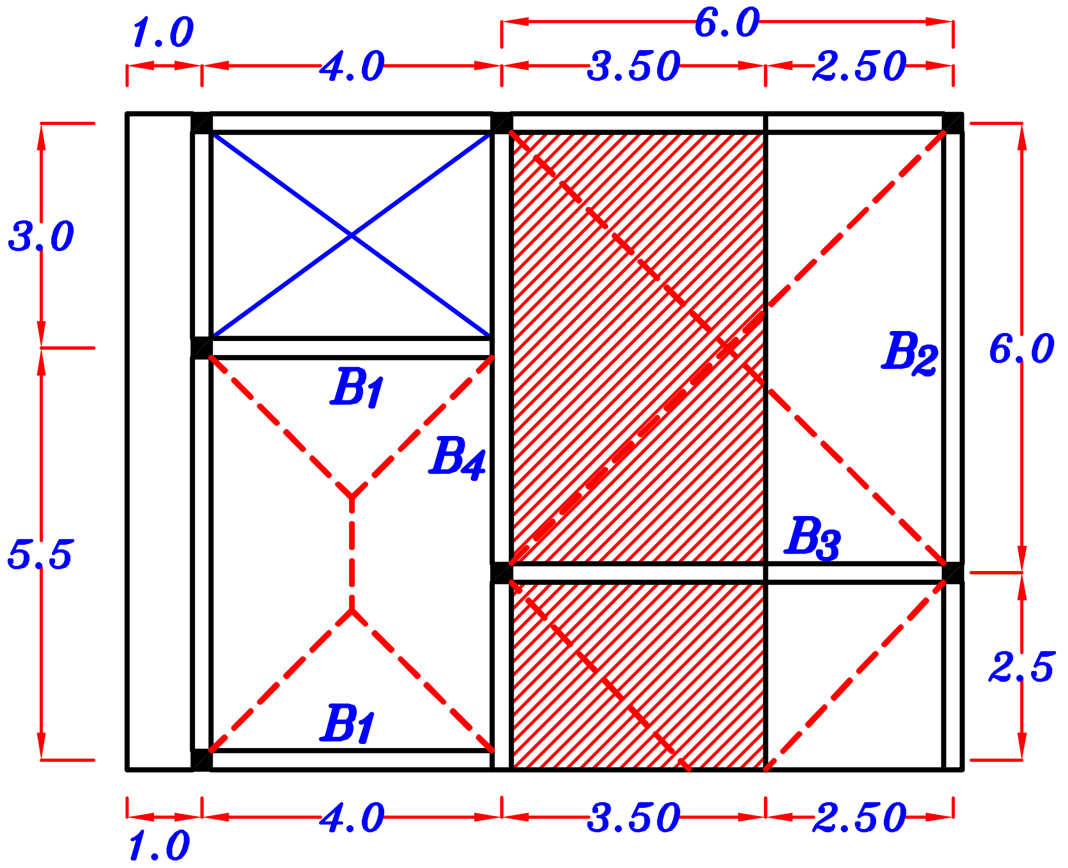
g_s, p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.5 = 5.0 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 2.0 \ kN\backslash m^2$$

$$p_{si} = L.L. * \cos\theta = 2.0 \cos 34.6 = 1.64 \ kN\backslash m^2$$

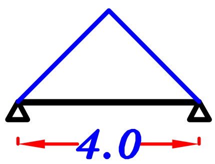
$\boxed{g_s = 5.0 \ kN\backslash m^2}$, $\boxed{p_{sh} = 2.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 1.64 \ kN\backslash m^2}$



B_1

$(250*400) \longrightarrow o.w. = 2.50 \ kN\backslash m'$

Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

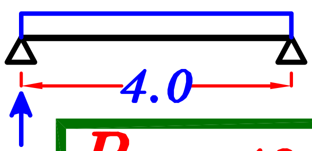


$$g_a = O.W. + C_a \ g_s \frac{L_s}{2} = 2.50 + \frac{1}{2}(5.0)(\frac{4.0}{2}) = 7.50 \ kN\backslash m'$$

$$p_a = C_a \ p_{sh} \frac{L_s}{2} = \frac{1}{2}(2.0)(\frac{4.0}{2}) = 2.0 \ kN\backslash m'$$

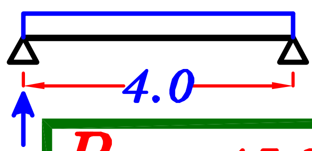
$$w_a = g_a + p_a = 7.50 + 2.0 = 9.50 \ kN\backslash m'$$

$w_a = 9.50 \ kN\backslash m'$



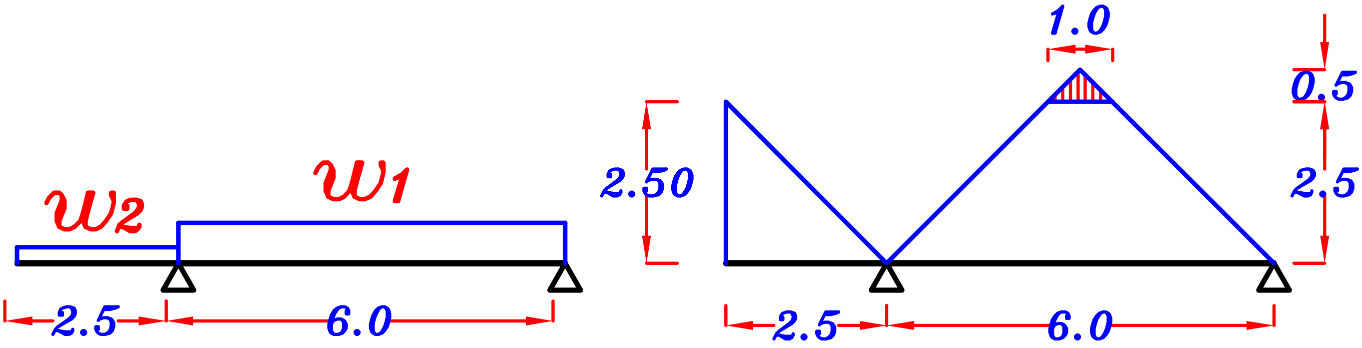
$\boxed{R_{1T} = 19.0 \ kN}$

$g_a = 7.50 \ kN\backslash m'$

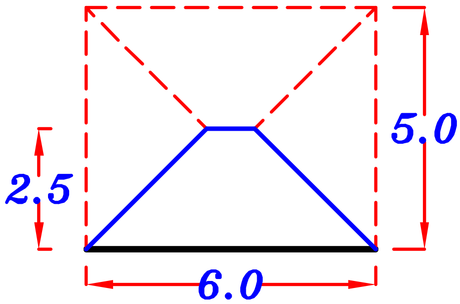


$\boxed{R_{1D} = 15.0 \ kN}$

B_2 (250*500) → o.w. = 3.12 kN\m`



w_1 For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.0}{6.0}\right) = 0.58$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.0}{6.0}\right)^2 = 0.77$$

For Triangle $\frac{\sum area}{span} = \frac{0.5\,(1.0)\,(0.5)}{6.0} = 0.0416$

Load For moment.

$$g_{1e} = o.w. + C_e\, g_s \frac{L_s}{2} + \frac{\sum area}{span} * g_s$$

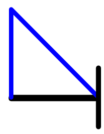
$$= 3.12 + (0.77)(5.0)(2.5) + (0.0416)(5.0) = 12.95 \ kN\backslash m`$$

$$p_{1e} = C_e\, p_{sh} \frac{L_s}{2} + \frac{\sum area}{span} * p_{si}$$

$$= (0.77)(2.0)(2.5) + (0.0416)(1.64) = 3.92 \ kN\backslash m`$$

$$w_{1e} = g_{1e} + p_{1e} = 12.95 + 3.92 = 16.87 \ kN\backslash m`$$

w_2 For Triangle



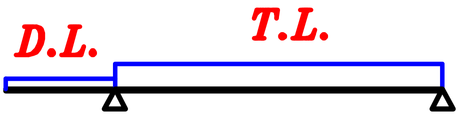
$$C_e = \frac{2}{3}$$

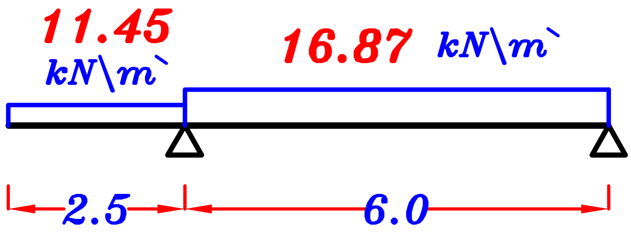
$$g_{2e} = o.w. + C_e\, g_s\, L_c = 3.12 + \left(\frac{2}{3}\right)(5.0)(2.5) = 11.45 \ kN\backslash m`$$

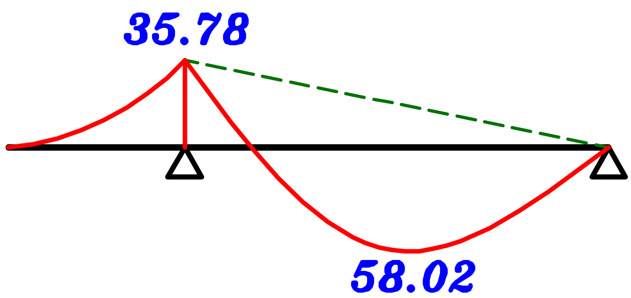
$$p_{2e} = C_e\, p_{sh}\, L_c = \left(\frac{2}{3}\right)(2.0)(2.5) = 3.33 \ kN\backslash m`$$

$$w_{2e} = g_{2e} + p_{2e} = 11.45 + 3.33 = 14.78 \ kN\backslash m`$$

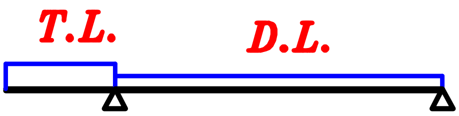
1- max. +ve B.M.D.

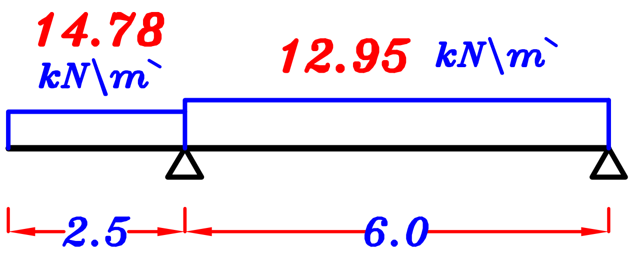


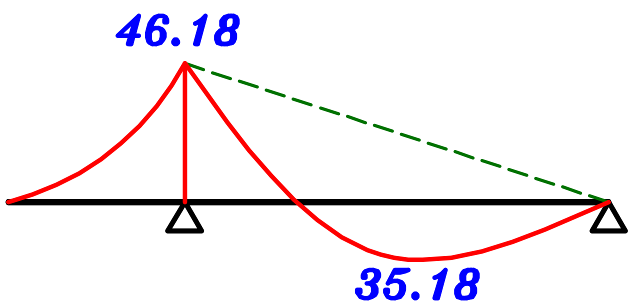




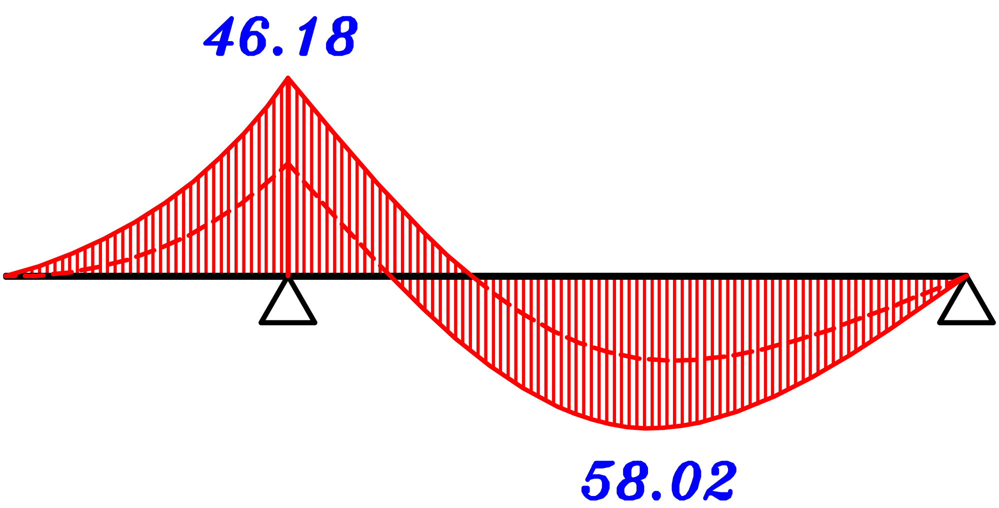
2- max. -ve B.M.D.



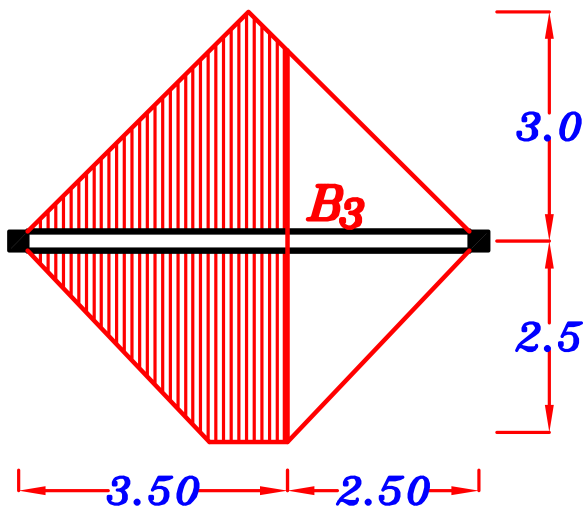


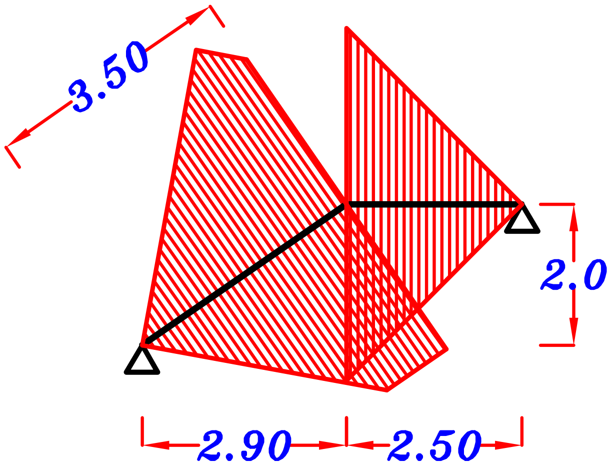


max.-max. B.M.D. B_2

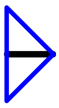


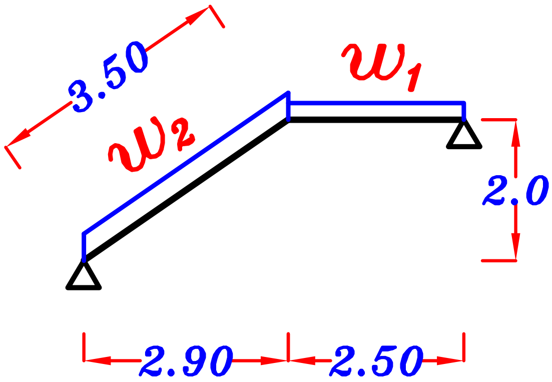
B_3 (250 * 600) $\longrightarrow$ o.w. = 3.75 kN\m`



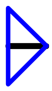


w_1 For Triangle





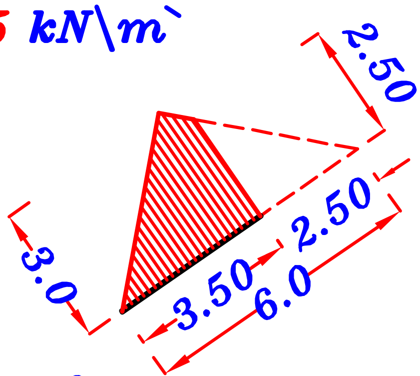
$$\frac{\sum area}{span} = \frac{2\,(0.5)(2.5)(2.5)}{2.50} = 2.50$$



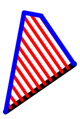
$$g_{1e} = o.w. + \frac{\sum area}{span} * g_s = 3.75 + (2.50)(5.0) = 16.25 \text{ kN\m`}$$

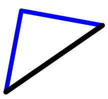
$$p_{1e} = \frac{\sum area}{span} * p_{sh} = (2.50)(2.0) = 5.0 \text{ kN\m`}$$

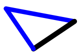
$$w_{1e} = g_{1e} + p_{1e} = 16.25 + 5.0 = 21.25 \text{ kN\m`}$$



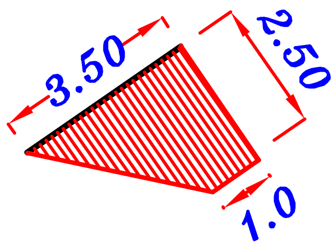
w_2 For area



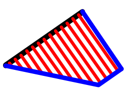




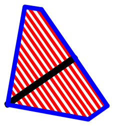
$$area = (0.5)(6.0)(3.0) - (0.5)(2.5)(2.5) = 5.875 \; m^2$$



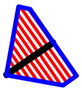
For area



$$\left(\frac{3.50 + 2.5}{2.0}\right)(2.5) = 7.50 \; m^2$$



$$\frac{\sum area}{span} = \frac{5.875+7.50}{3.50} = 3.82$$

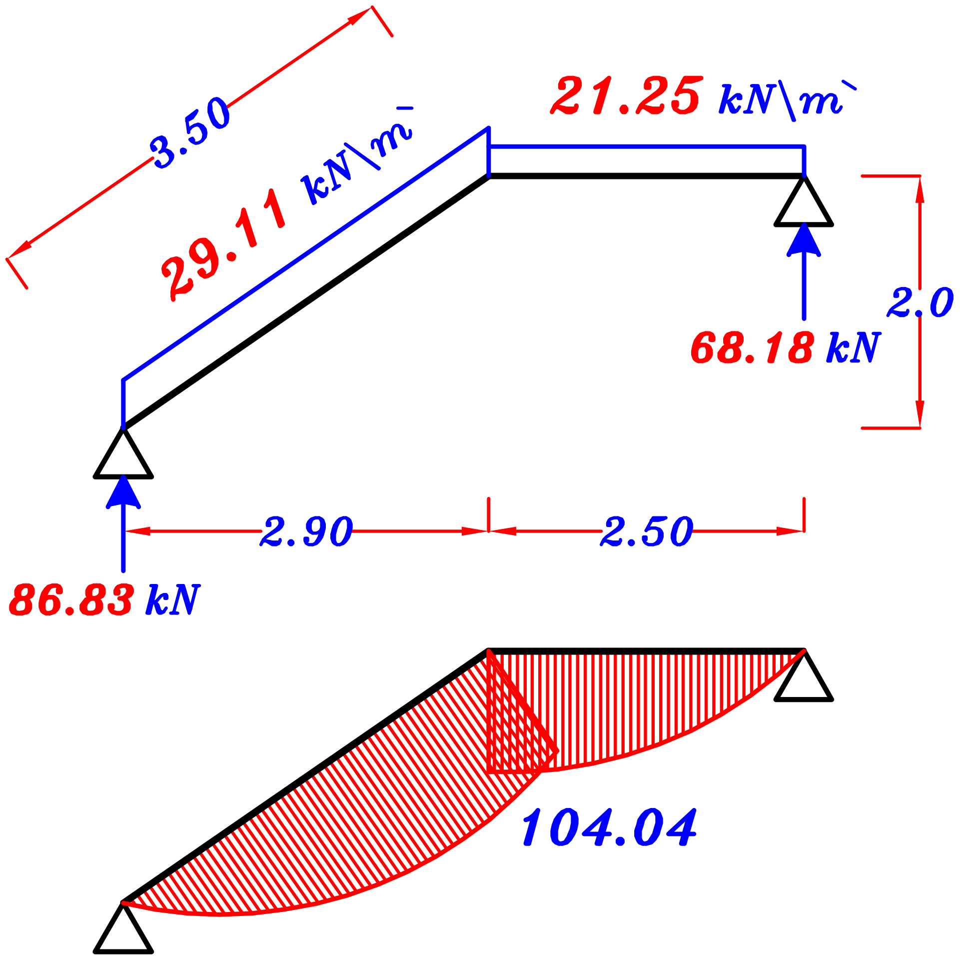


$$g_{2e} = o.w. + \frac{\sum area}{span} * g_s = 3.75 + (3.82)(5.0) = 22.85 \ kN\backslash m'$$

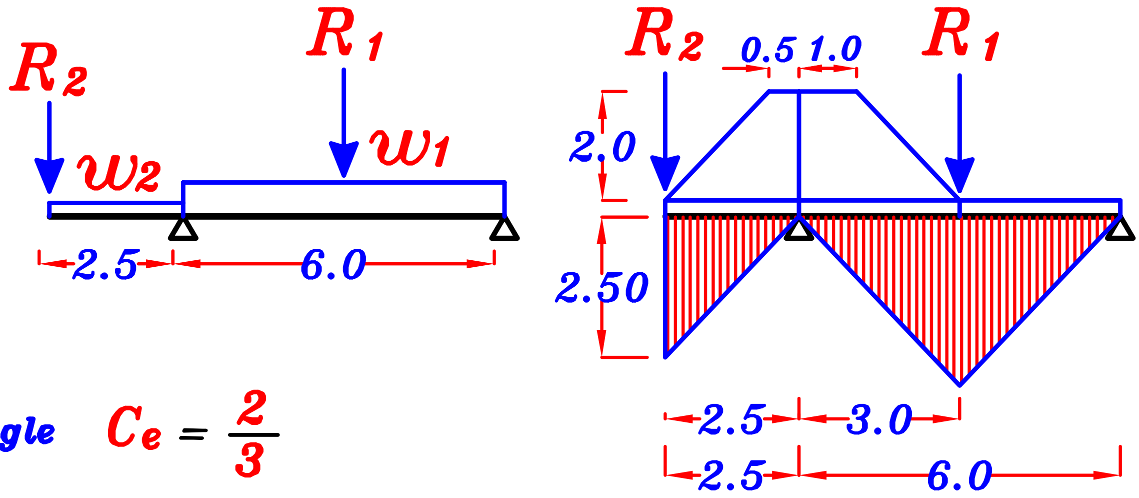
$$p_{2e} = \frac{\sum area}{span} * p_{si} = (3.82)(1.64) = 6.26 \ kN\backslash m'$$

$$w_{2e} = g_{2e} + p_{2e} = 22.85 + 6.26 = 29.11 \ kN\backslash m'$$

max.−max. B.M.D. B_3



B_4 (250*500) → o.w. = 3.12 kN\m`



w_1

For Triangle $C_e = \frac{2}{3}$

For Trapezoid $\frac{\sum area}{span} = \frac{\left(\frac{3.0+1.0}{2.0}\right)(2.0)}{6.0} = 0.67$

$$g_{1e} = o.w. + C_e\, g_s \frac{L_s}{2} + \frac{\sum area}{span} * g_s$$

$$= 3.12 + \left(\frac{2}{3}\right)(5.0)(3.0) + (0.67)(5.0) = 16.47 \text{ kN\m`}$$

$$p_{1e} = C_e\, p_{si} \frac{L_s}{2} + \frac{\sum area}{span} * p_{sh}$$

$$= \left(\frac{2}{3}\right)(1.64)(3.0) + (0.67)(2.0) = 4.62 \text{ kN\m`}$$

$$w_{1e} = g_{1e} + p_{1e} = 16.47 + 4.62 = 21.09 \text{ kN\m`}$$

w_2

For Triangle $C_e = \frac{2}{3}$

For Trapezoid $\frac{\sum area}{span} = \frac{\left(\frac{2.5+0.5}{2.0}\right)(2.0)}{2.5} = 1.20$

$$g_{2e} = o.w. + C_e\, g_s\, L_c + \frac{\sum area}{span} * g_s$$

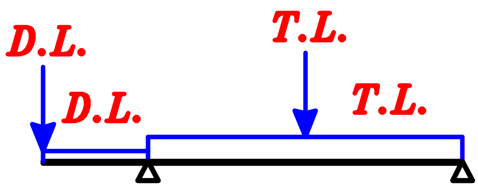
$$= 3.12 + \left(\frac{2}{3}\right)(5.0)(2.5) + (1.20)(5.0) = 17.45 \text{ kN\m`}$$

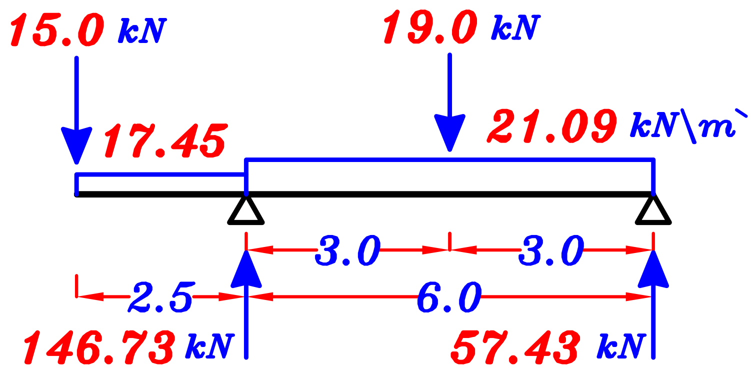
$$p_{2e} = C_e\, p_{si}\, L_c + \frac{\sum area}{span} * p_{sh}$$

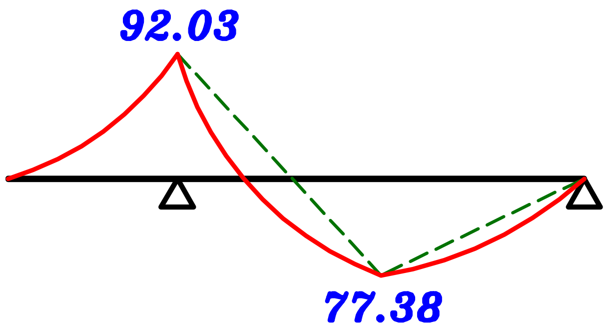
$$= \left(\frac{2}{3}\right)(1.64)(2.5) + (1.20)(2.0) = 5.13 \text{ kN\m`}$$

$$w_{2e} = g_{2e} + p_{2e} = 17.45 + 5.13 = 22.58 \text{ kN\m`}$$

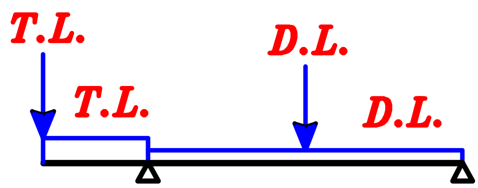
1- max. +ve B.M.D.

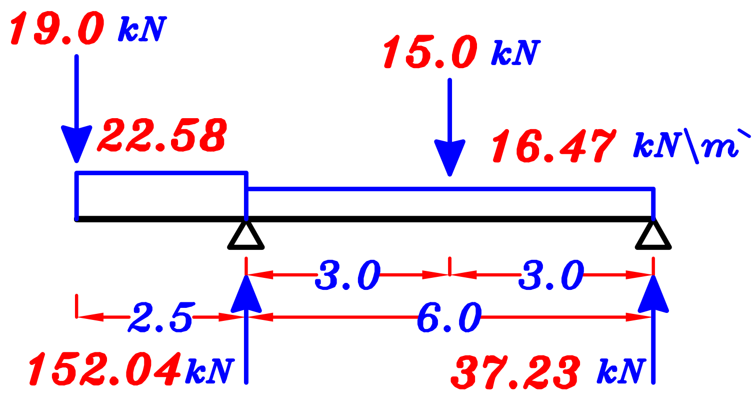


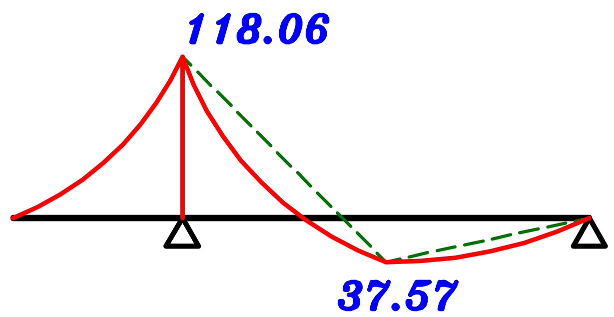




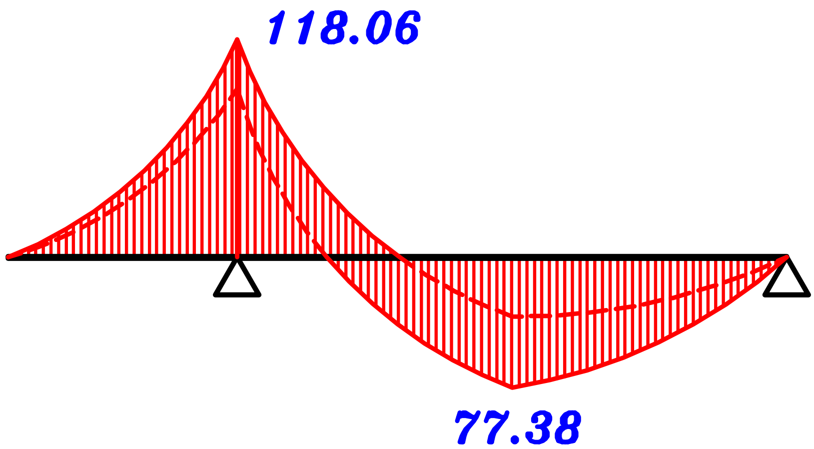
2- max. −ve B.M.D.







max.−max. B.M.D. B_4



Example.

The **Figure** shows a sectional elevation of a reinforced concrete roof. The roof is covered by reinforced concrete slabs supported by a system of secondary beams and Frames **(F)** spaced at **5.0 m.** For an intermediate panel, it is required to :

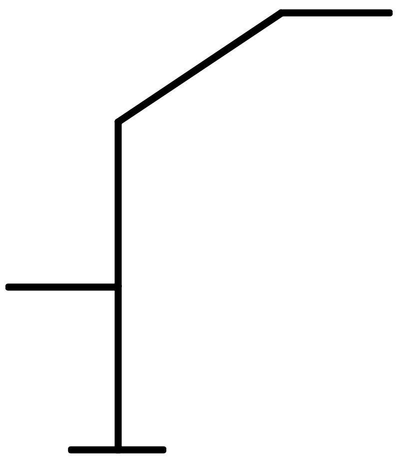
1 – Draw a structural plan showing the pattern of load distribution.

2 – Calculate the equivalent working loads for shear and moment For all secondary beams **(B_1 , B_2 , B_3 & B_4)** and an intermediate Frame **(F)** .

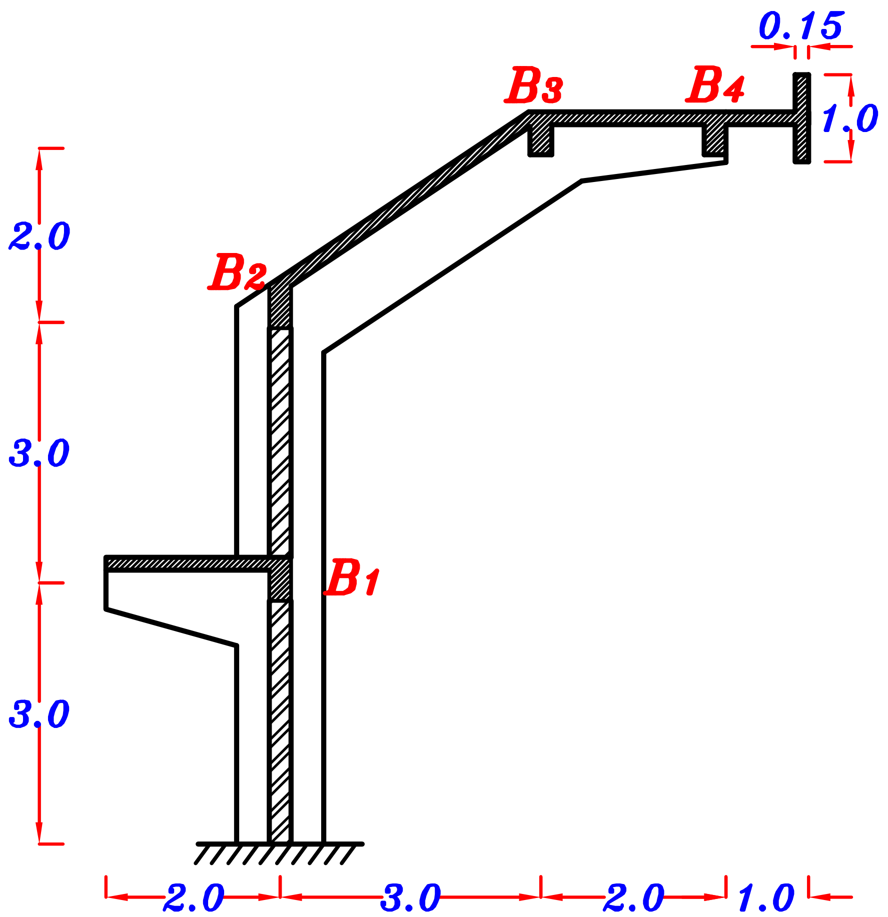
3 – Draw the **N.F.D.** (total load) , **S.F.D.** (total load) and **max–max B.M.D.** For an intermediate Frame **(F)** , **using ultimate limit loads.**

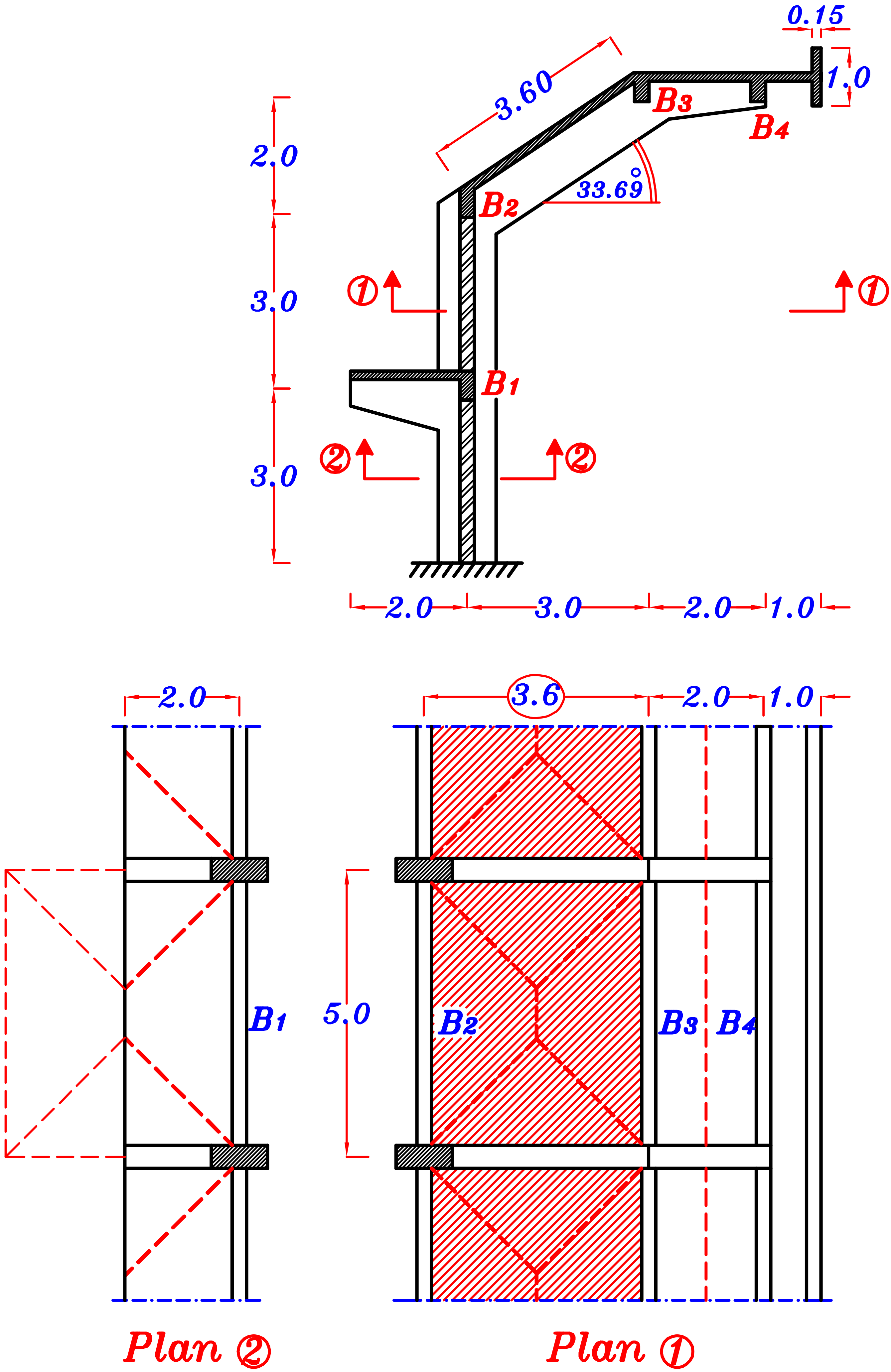
Data:

- Slab thickness $t_s = 120\ mm$
- Live load $= 1.0\ kN\backslash m^2$ HL. projection.
- Floor cover $= 1.5\ kN\backslash m^2$
- $b_{(beams)} = 0.25\ m$, $b_{(Frame)} = 0.30\ m$, $\gamma_{brick} = 18\ kN\backslash m^3$
- Own weight of beams $= 3.0\ kN\backslash m$
- Own weight of Frame $= 6.0\ kN\backslash m$



Statical System




0.15
1.0
3.60
B3
B4
2.0
33.69°
B2
3.0
①
①
B1
3.0
②
②
2.0
3.0
2.0
1.0
2.0
3.6
2.0
1.0
B1
5.0
B2
B3
B4
Plan ②
Plan ①

2 – Calculate the equivalent working loads for shear and moment For all secondary beams (B_1 , B_2 , B_3 & B_4) and an intermediate Frame (**F**) .

g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \ kN\backslash m^2$

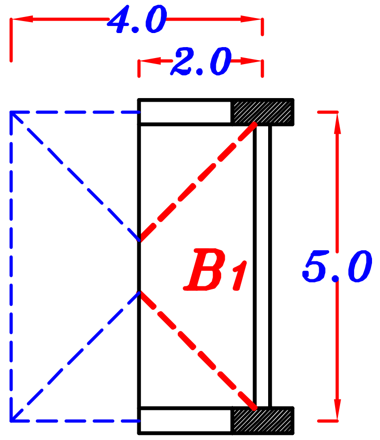
$p_{sh} = L.L. = 1.0 \ kN\backslash m^2$ ------ HL. Slab.

$p_{si} = L.L. * Cos\,\theta = 1.0 * Cos\,33.69^{\circ} = 0.83 \ kN\backslash m^2$ ------ Inclined Slab.

$\boxed{g_s = 4.50 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 0.83 \ kN\backslash m^2}$

B_1

Weight of Wall $= b\,h\,\gamma_{bricks} = (0.25)(3.0)(18.0) = 13.50 \ kN/m$



For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$$

$$C_e = 1 - \frac{1}{3}\left(\frac{2L_c}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{5}\right)^2 = 0.78$$

Load For Shear.

$g_a = O.W. + Wall + C_a\, g_s\, L_c = 3.0 + 13.5 + (0.60)(4.50)(2.0) = 21.9 \ kN\backslash m'$

$p_a = C_a\, p_{sh}\, L_c = (0.60)(1.0)(2.0) = 1.20 \ kN\backslash m'$

$w_a = g_a + p_a = 21.9 + 1.20 = 23.1 \ kN\backslash m'$

$R_1 = g_a * Spacing = 21.9 * 5.0 = 109.5 \ kN$ ------ D.L.

$\quad = w_a * Spacing = 23.1 * 5.0 = 115.5 \ kN$ ------ T.L.

$$\boxed{\begin{aligned} R_1 &= 109.5 \ kN \text{ ---- D.L.} \\ &= 115.5 \ kN \text{ ---- T.L.} \end{aligned}}$$

Load For Moment.

$g_e = O.W. + Wall + C_e\, g_s\, L_c = 3.0 + 13.5 + (0.78)\,(4.50)\,(2.0) = 23.52$ kN\m`

$p_e = C_e\, p_{sh}\, L_c = (0.78)(1.0)(2.0) = 1.56$ kN\m`

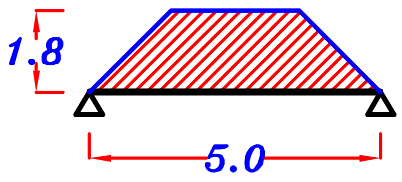
$w_e = g_e + p_e = 23.52 + 1.56 = 25.08$ kN\m`

B_2

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.60}{5}\right) = 0.64$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.60}{5}\right)^2 = 0.83$$



Load For Shear.

$g_a = O.W. + C_a\, g_s\, \frac{L_s}{2} = 3.0 + (0.64)\,(4.50)\,\left(\frac{3.6}{2}\right) = 8.18$ kN\m`

$p_a = C_a\, p_{si}\, \frac{L_s}{2} = (0.64)(0.83)\left(\frac{3.6}{2}\right) = 0.95$ kN\m`

$w_a = g_a + p_a = 8.18 + 0.95 = 9.13$ kN\m`

$R_2 = g_a * Spacing = 8.18 * 5.0 = 40.9$ kN ------ D.L.

$= w_a * Spacing = 9.13 * 5.0 = 45.65$ kN ------ T.L.

$$\boxed{\begin{aligned} R_2 &= 40.9\ \text{kN} \text{ ------ D.L.} \\ &= 45.65\ \text{kN} \text{ ----- T.L.} \end{aligned}}$$

Load For Moment.

$g_e = O.W. + C_e\, g_s\, \frac{L_s}{2} = 3.0 + (0.83)\,(4.50)\,\left(\frac{3.6}{2}\right) = 9.72$ kN\m`

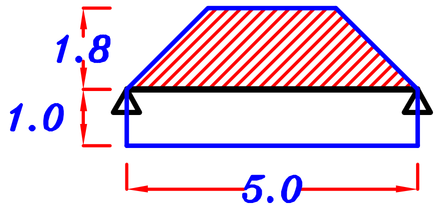
$p_e = C_e\, p_{si}\, \frac{L_s}{2} = (0.83)(0.83)\left(\frac{3.6}{2}\right) = 1.24$ kN\m`

$w_e = g_e + p_e = 9.72 + 1.24 = 10.96$ kN\m`

B_3 For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.60}{5}\right) = 0.64$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.60}{5}\right)^2 = 0.83$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

$$= 3.0 + (0.64)(4.50)\left(\frac{3.6}{2}\right) + (4.50)\left(\frac{2.0}{2}\right) = 12.68 \text{ kN}\backslash m'$$

$$P_a = C_a\, P_{si} \frac{L_s}{2} + P_{sh} \frac{L_s}{2} = (0.64)(0.83)\left(\frac{3.6}{2}\right) + (1.0)\left(\frac{2.0}{2}\right) = 1.95 \text{ kN}\backslash m'$$

$$w_a = g_a + P_a = 12.68 + 1.95 = 14.63 \text{ kN}\backslash m'$$

$$R_3 = g_a * \text{Spacing} = 12.68 * 5.0 = 63.4 \text{ kN} \text{ ------ } D.L.$$

$$= w_a * \text{Spacing} = 14.63 * 5.0 = 73.15 \text{ kN} \text{ ------ } T.L.$$

$$\boxed{\begin{aligned} R_3 &= 63.4 \text{ kN ---- } D.L. \\ &= 73.15 \text{ kN ---- } T.L. \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

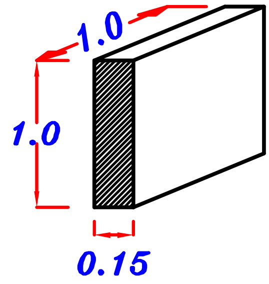
$$= 3.0 + (0.83)(4.50)\left(\frac{3.6}{2}\right) + (4.50)\left(\frac{2.0}{2}\right) = 14.22 \text{ kN}\backslash m'$$

$$P_e = C_e\, P_{si} \frac{L_s}{2} + P_{sh} \frac{L_s}{2} = (0.83)(0.83)\left(\frac{3.6}{2}\right) + (1.0)\left(\frac{2.0}{2}\right) = 2.24 \text{ kN}\backslash m'$$

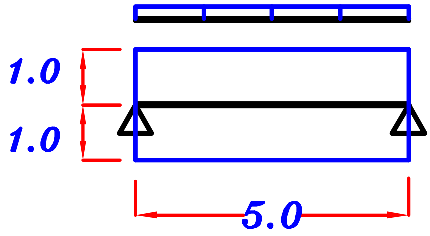
$$w_e = g_e + P_e = 14.22 + 2.24 = 16.46 \text{ kN}\backslash m'$$

B_4

O.W. of the Parapet $= (0.15)(1.0)(1.0)(25) = 3.75\ kN\backslash m$



Load For Shear. = **Load For Moment.**



$$g_a = O.W. + Parapet + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.0 + 3.75 + (4.50)\left(\frac{2.0}{2}\right) + (4.50)(1.0) = 15.75\ kN\backslash m'$$

$$p_a = p_{sh}\frac{L_s}{2} + p_{sh} L_c = (1.0)\left(\frac{2.0}{2}\right) + (1.0)(1.0) = 2.0\ kN\backslash m'$$

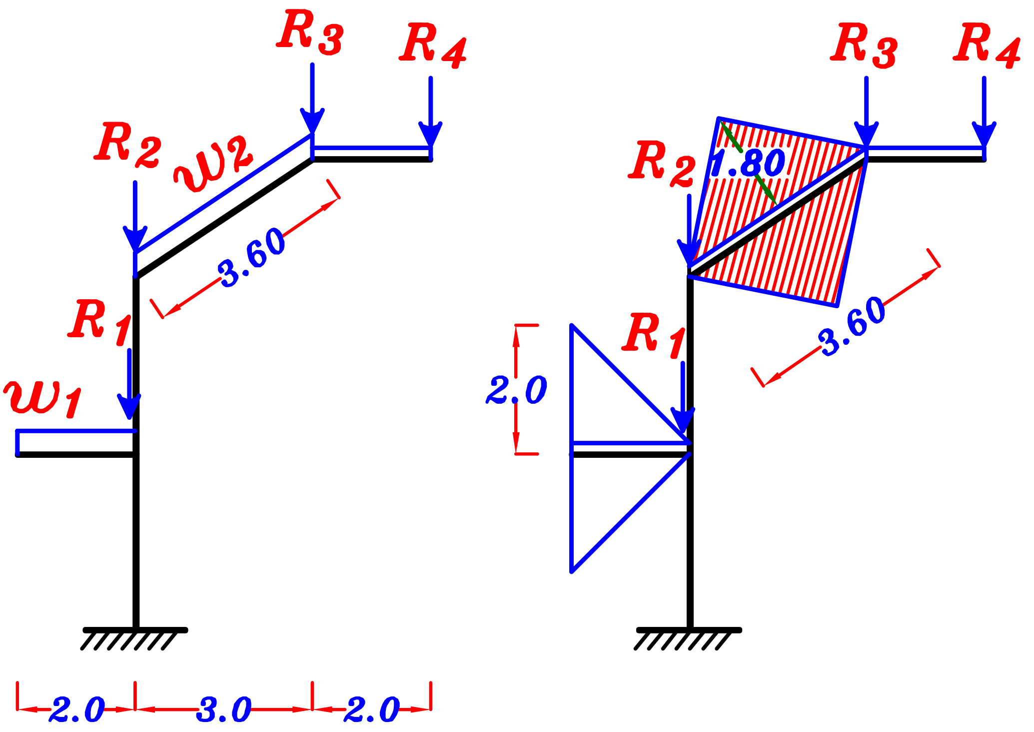
$$w_a = g_a + p_a = 15.75 + 2.0 = 17.75\ kN\backslash m'$$

$$R_4 = g_a * Spacing = 15.75 * 5.0 = 78.75\ kN \text{ ----- D.L.}$$

$$= w_a * Spacing = 17.75 * 5.0 = 88.75\ kN \text{ ----- T.L.}$$

$$\boxed{\begin{aligned} R_4 &= 78.75\ kN \text{ ----- D.L.} \\ &= 88.75\ kN \text{ ----- T.L.} \end{aligned}}$$

Frame.



W_1

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

$$g_a = O.W. + 2\, C_a\, g_s\, L_c = 6.0 + 2\left(\tfrac{1}{2}\right)(4.5)(2.0) = 15.0 \ kN\backslash m'$$

$$P_a = 2\, C_a\, P_{sh}\, L_c = 2\left(\tfrac{1}{2}\right)(1.0)(2.0) = 2.0 \ kN\backslash m'$$

$$W_a = g_a + P_a = 15.0 + 2.0 = 17.0 \ kN\backslash m'$$

$$g_e = O.W. + 2\, C_e\, g_s\, L_c = 6.0 + 2\left(\tfrac{2}{3}\right)(4.5)(2.0) = 18.0 \ kN\backslash m'$$

$$P_e = 2\, C_e\, P_{sh}\, L_c = 2\left(\tfrac{2}{3}\right)(1.0)(2.0) = 2.67 \ kN\backslash m'$$

$$W_e = g_e + P_e = 18.0 + 2.67 = 20.67 \ kN\backslash m'$$

W_2

$$\frac{\sum area}{span} = \frac{2\left(\tfrac{1}{2}(3.6)(1.8)\right)}{3.6} = 1.80$$

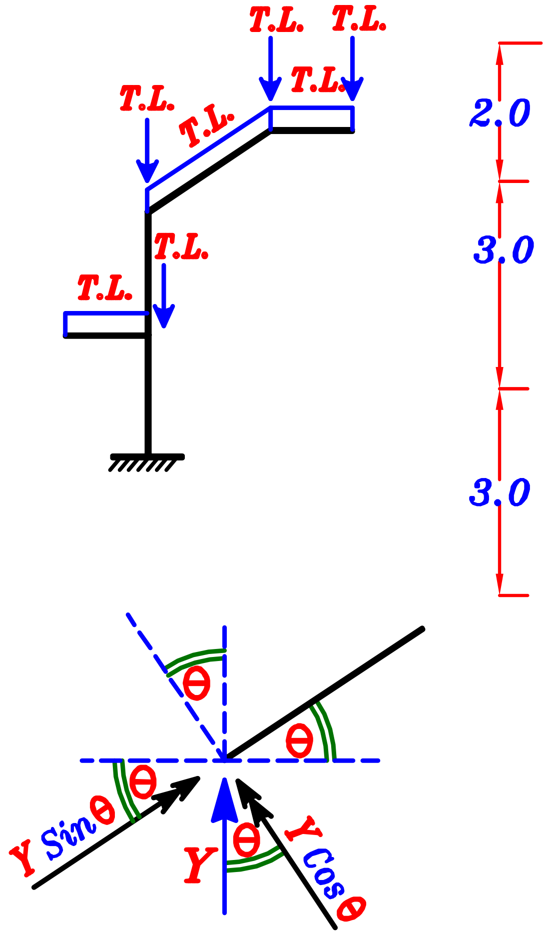
$$g_a = g_e = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.80)(4.50) = 14.1 \ kN\backslash m'$$

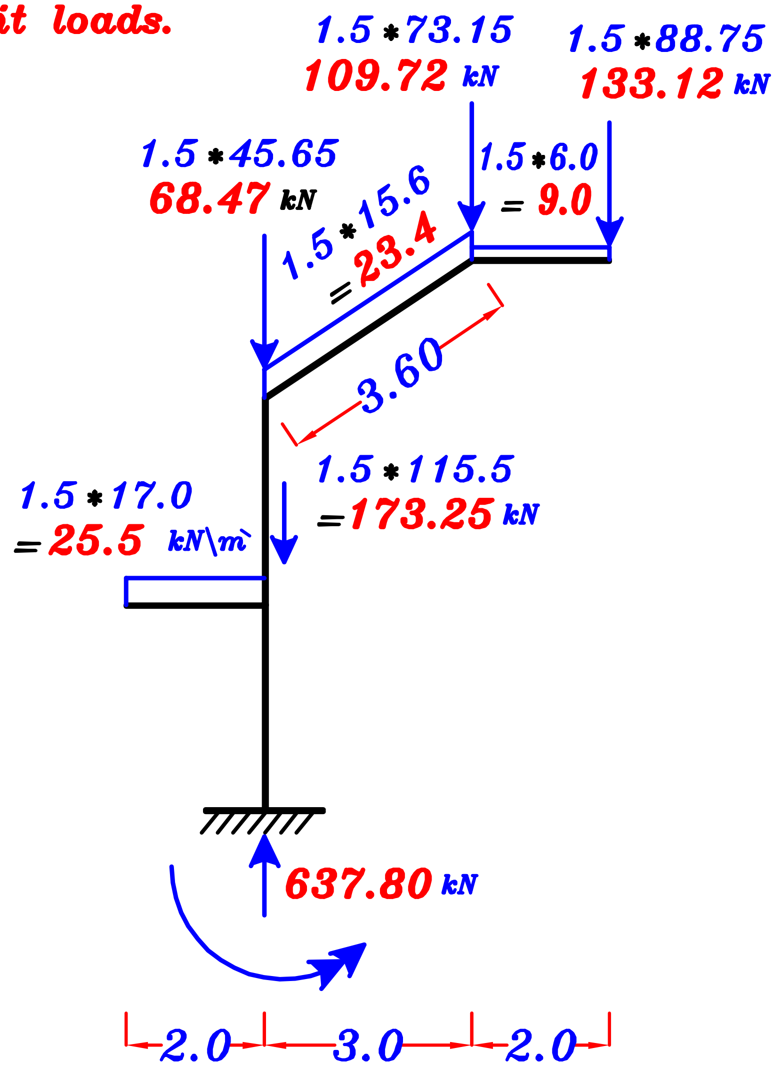
$$P_a = P_e = \frac{\sum area}{span} * P_{si} = (1.80)(0.83) = 1.50 \ kN\backslash m'$$

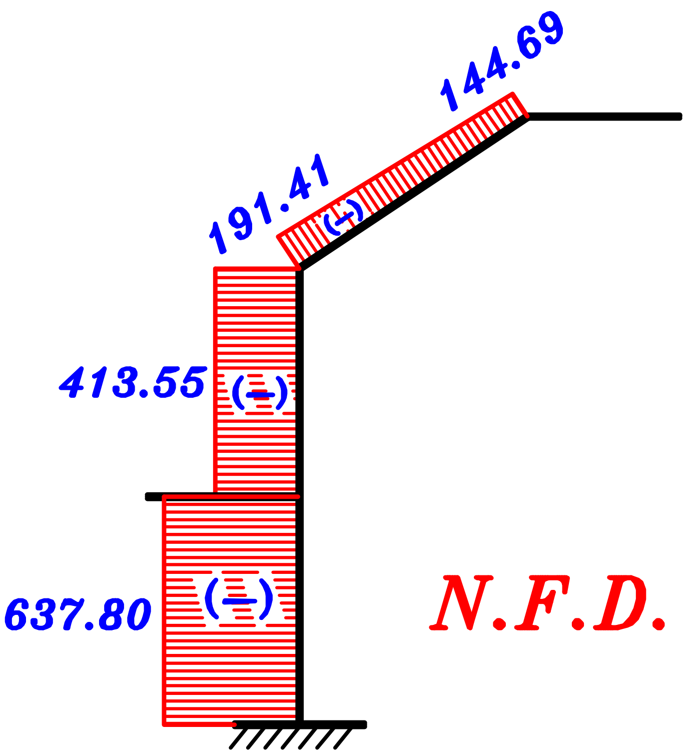
$$W_a = W_e = g_a + P_a = 14.1 + 1.50 = 15.60 \ kN\backslash m'$$

3- Draw the N.F.D. (total load), S.F.D. (total load) For an intermediate Frame (F)

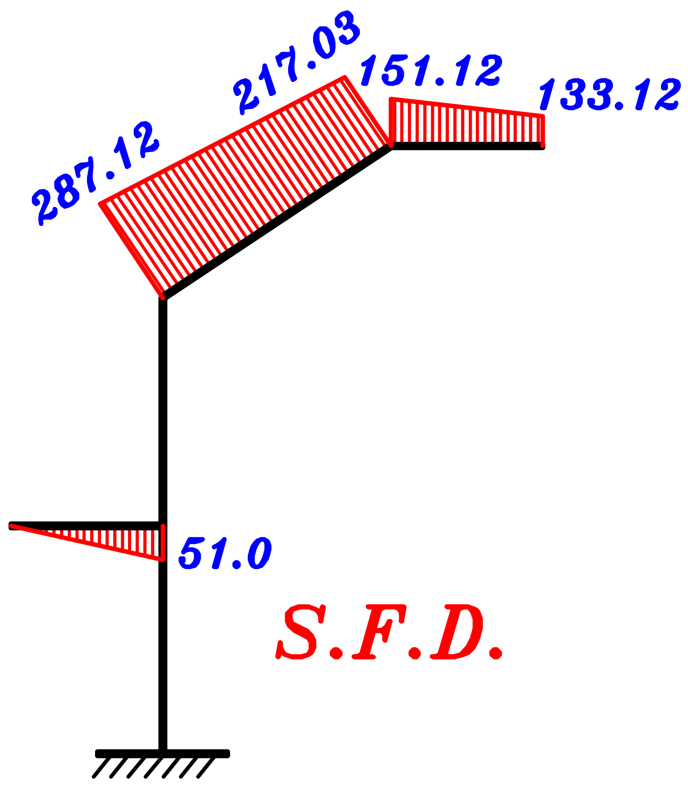
using ultimate limit loads.





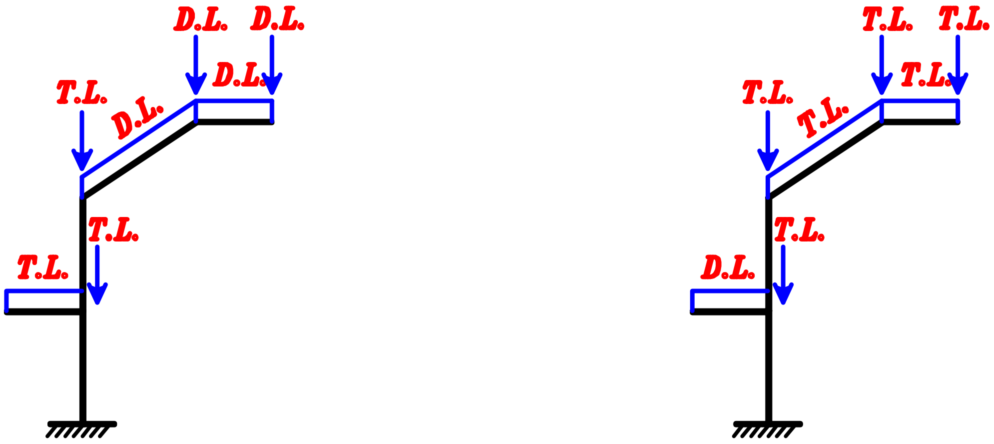


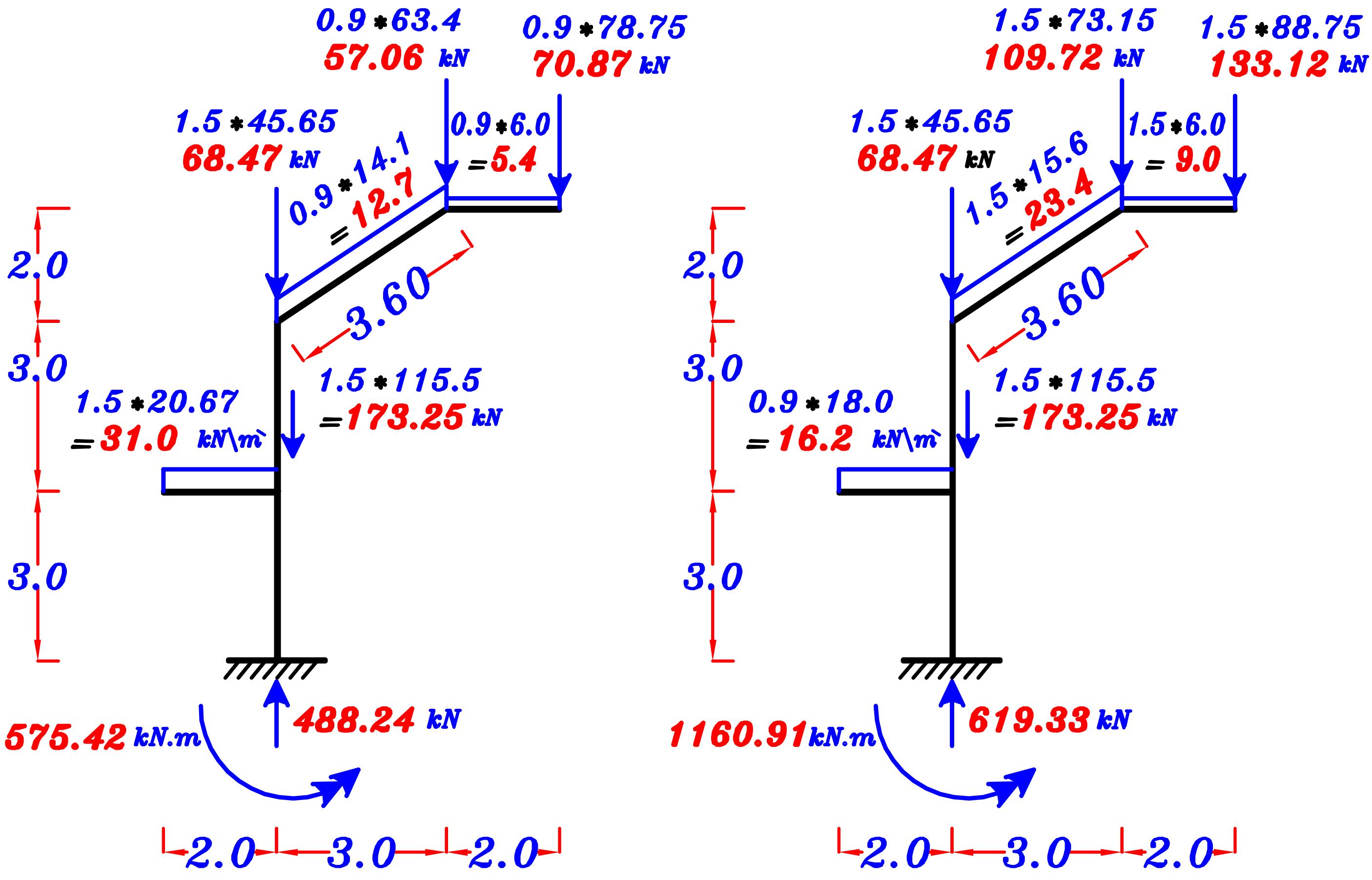
N.F.D.

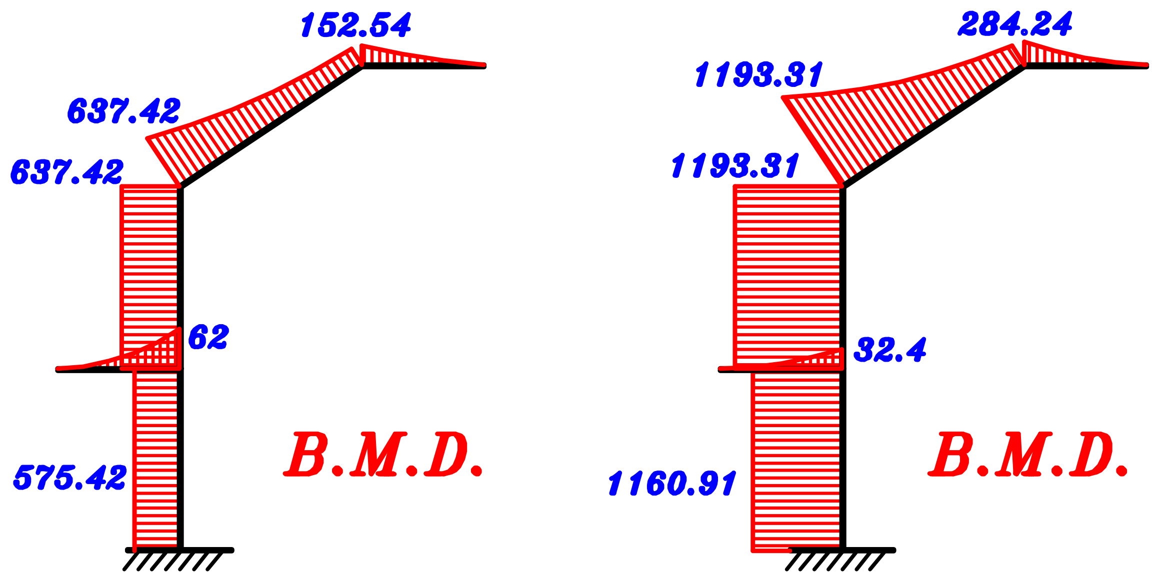


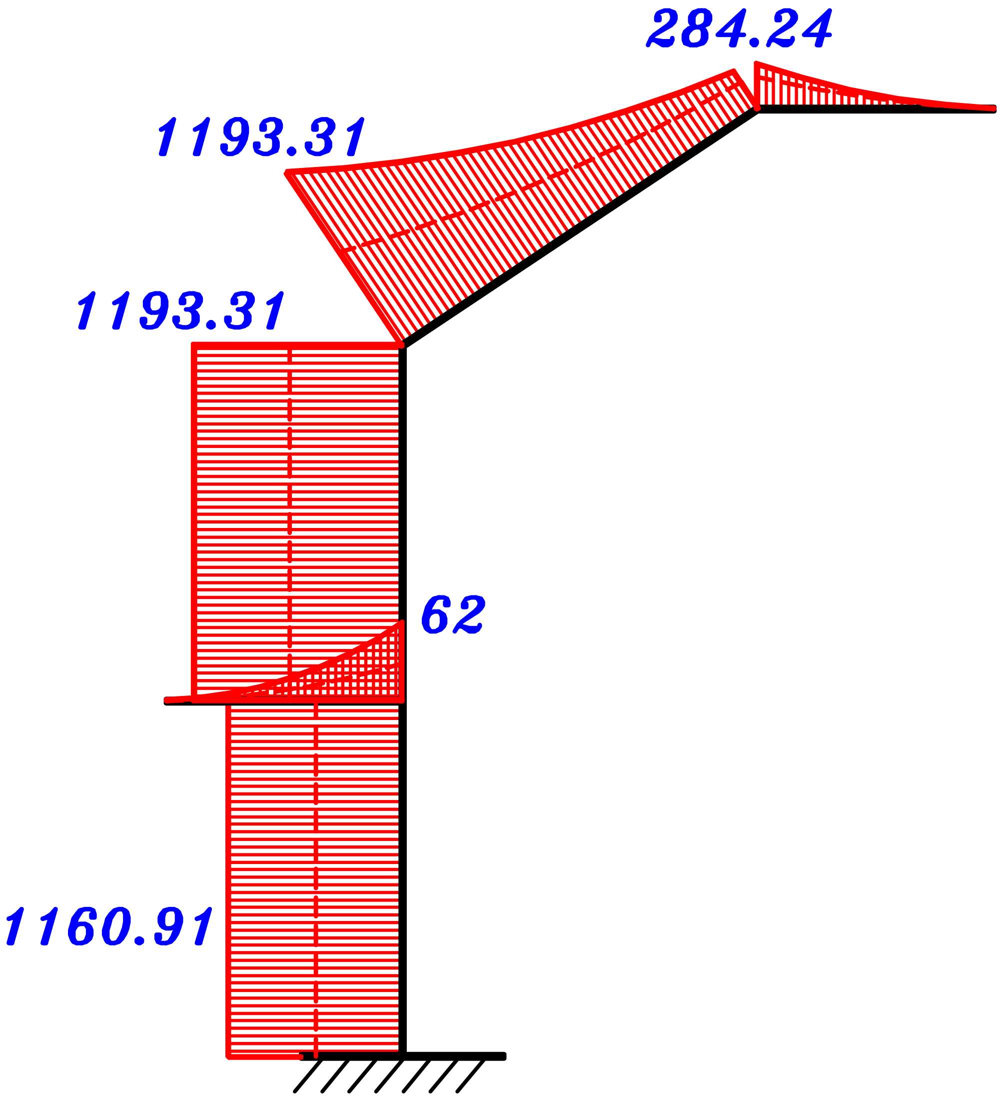
S.F.D.

3 – Draw the max–max B.M.D. For an intermediate Frame (F) using ultimate limit loads.









max-max B.M.D.

Example.

Figure 1 is showing the structural section of the covering system of a reinforced concrete hall. Using the Following data:

- The slab thickness $t_s = 140$ mm
- The density of used bricks = 15 $kN\backslash m^3$
- Live Load = 2.0 $kN\backslash m^2$
- Floor cover Load = 1.50 $kN\backslash m^2$
- Self weight of all beams and girders = 3.50 $kN\backslash m$
- Spacing of the main girders = 6.0 m

It is required :

1 – Draw the structural plans A–A & B–B showing the pattern of slab load distribution on all Beams.

2 – Calculate the equivalant loads For shear and moment For all beams.

3 – Draw the max–max bending moment diagram For girder G using Ultimate limits loads.

4 – Draw the shearing Force diagram For the case of total load only For girder G .

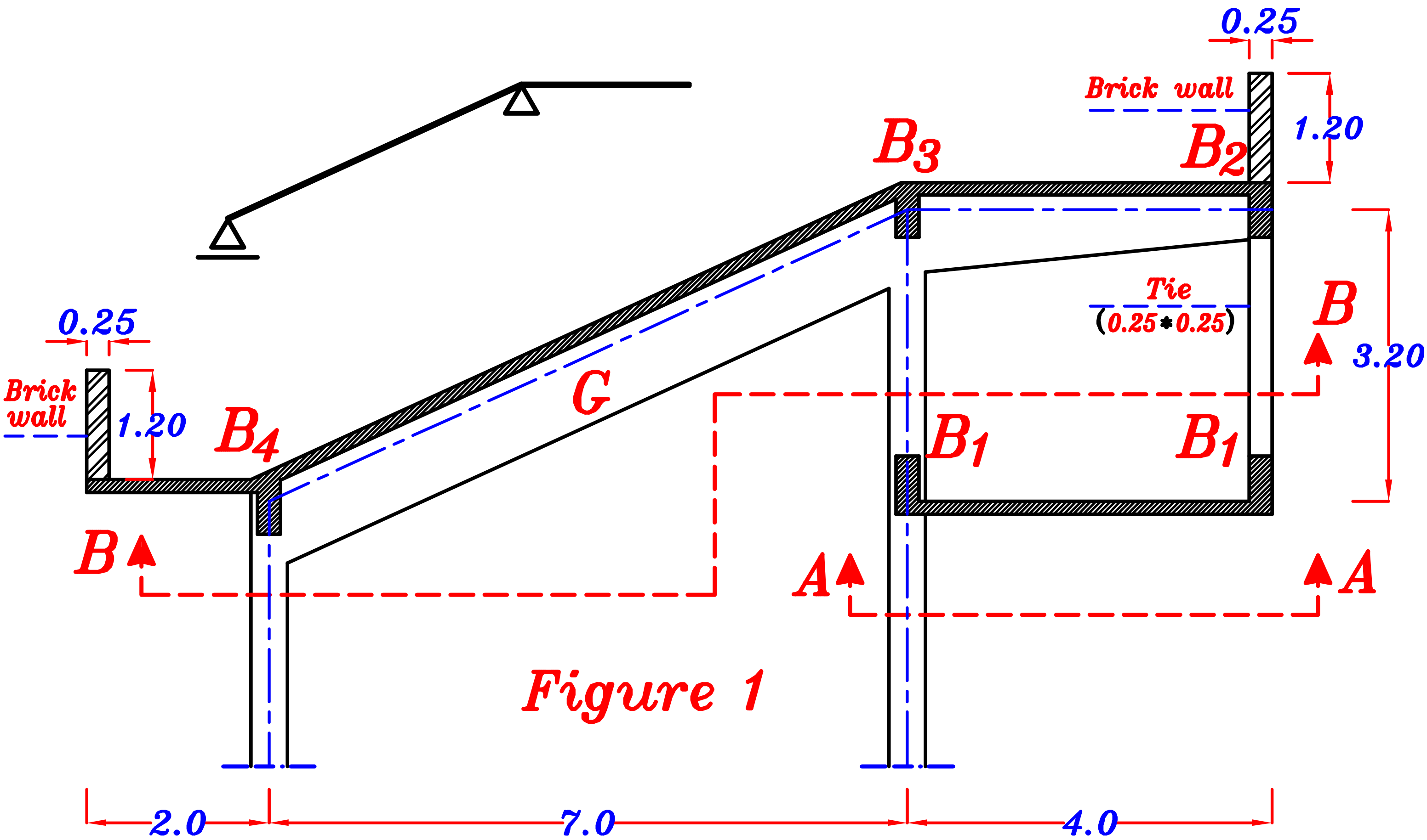


Figure 1

1 – Draw the structural plans A–A & B–B showing the pattern of slab load distribution on all Beams.

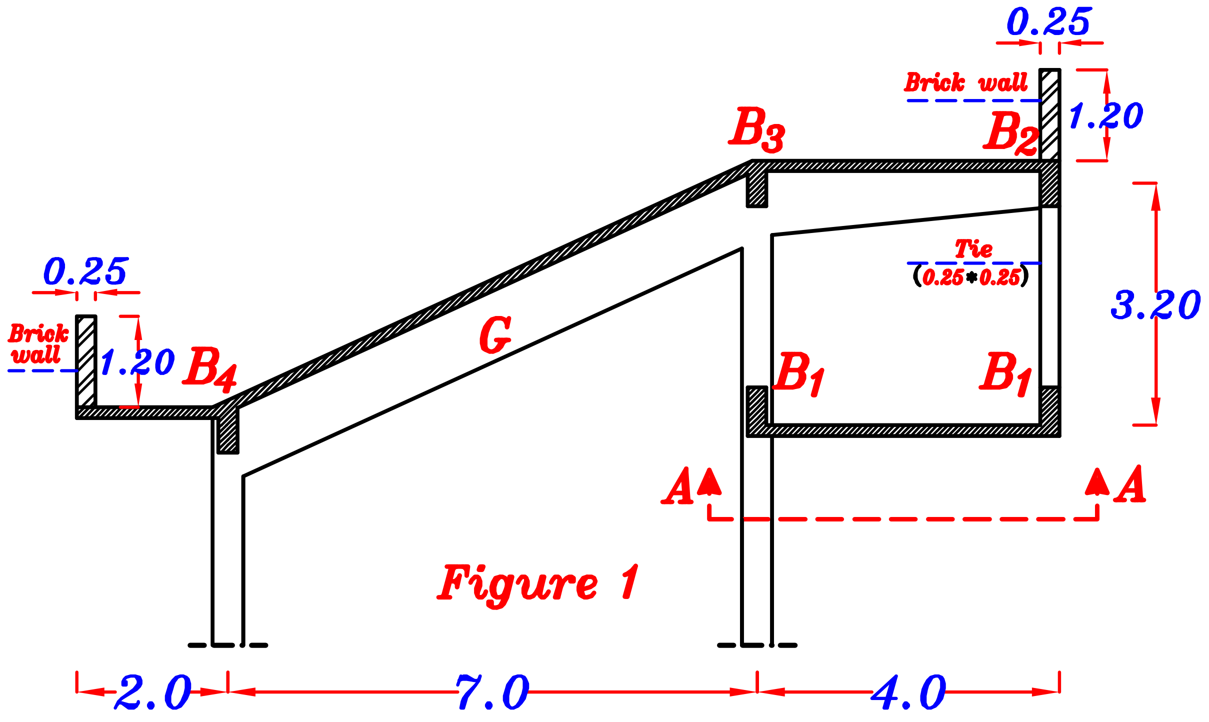
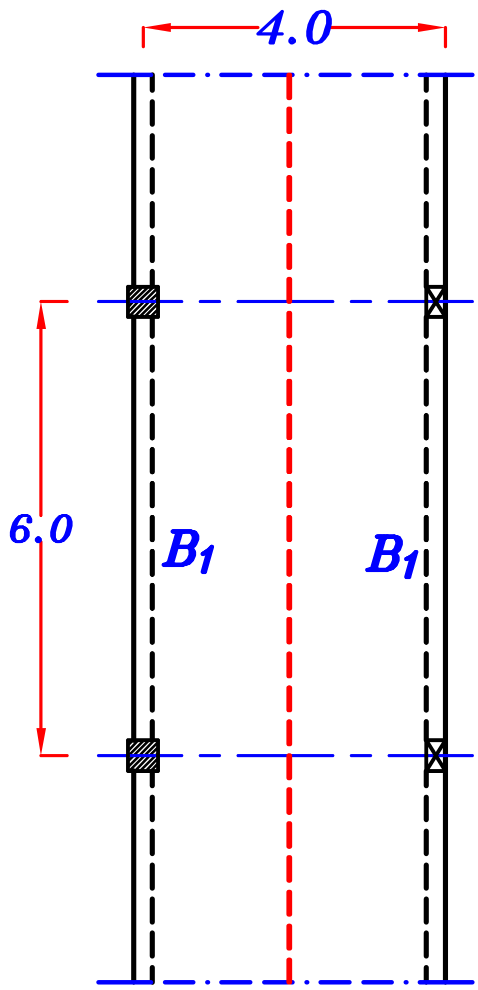


Figure 1



Plan A–A

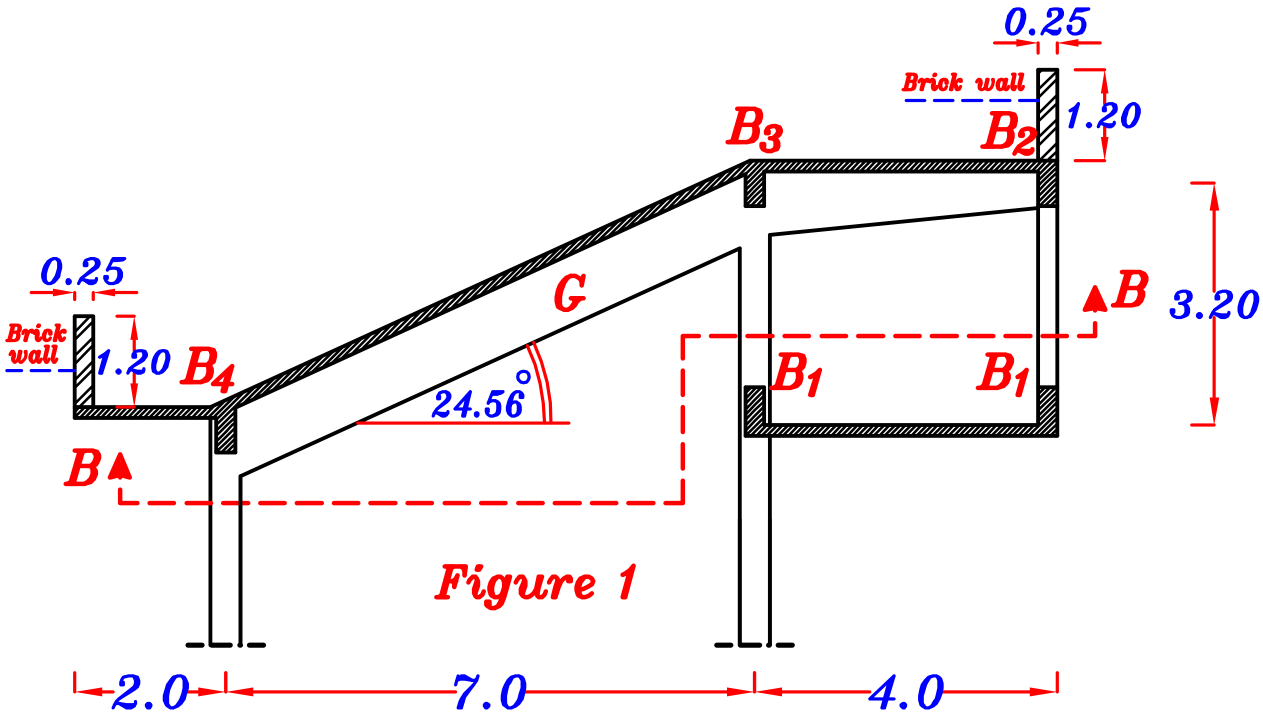
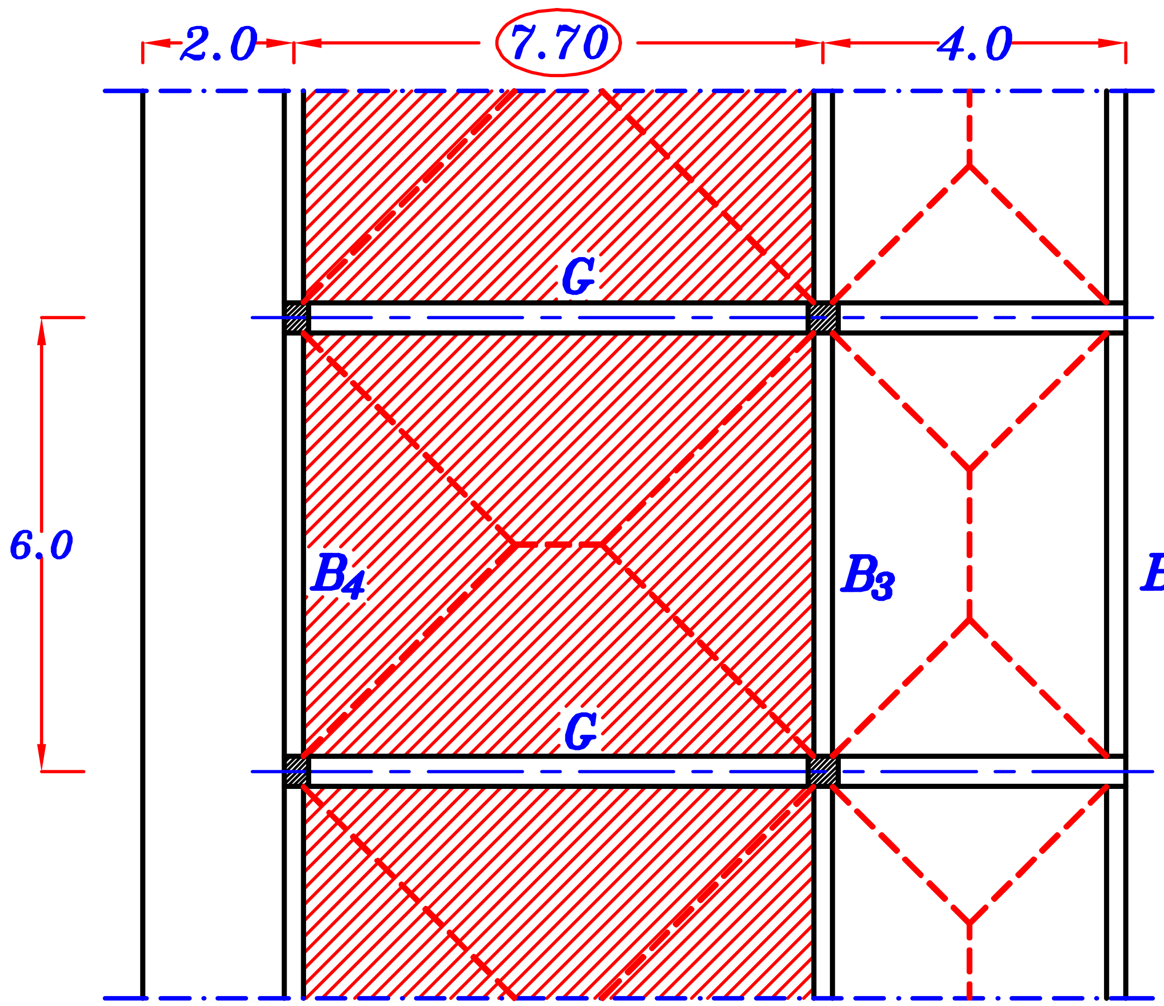


Figure 1



Plan B–B

2- Calculate the equivalant loads For shear and moment For all beams.

g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.50 = 5.0 \ kN\backslash m^2$

$p_{sh} = L.L. = 2.0 \ kN\backslash m^2$ ------ HL. Slab.

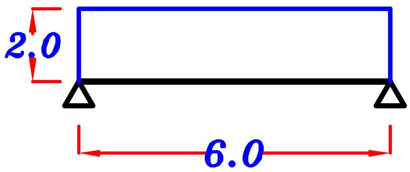
$p_{si} = L.L. * \cos\theta = 2.0 * \cos 24.56^\circ = 1.82 \ kN\backslash m^2$ ------ Inclined Slab.

$\boxed{g_s = 5.0 \ kN\backslash m^2}$, $\boxed{p_{sh} = 2.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 1.82 \ kN\backslash m^2}$

B1 Load For Shear. = Load For Moment.

$g_a = g_e = O.W. + g_s \frac{L_s}{2} = 3.5 + (5.0)\left(\frac{4.0}{2}\right)$

$= 13.50 \ kN\backslash m`$



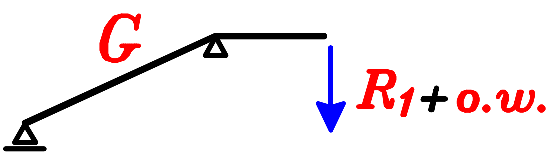
$p_a = p_e = p_{sh} \frac{L_s}{2} = (2.0)\left(\frac{4.0}{2}\right) = 4.0 \ kN\backslash m`$

$w_a = g_a + p_a = 13.50 + 4.0 = 17.50 \ kN\backslash m`$

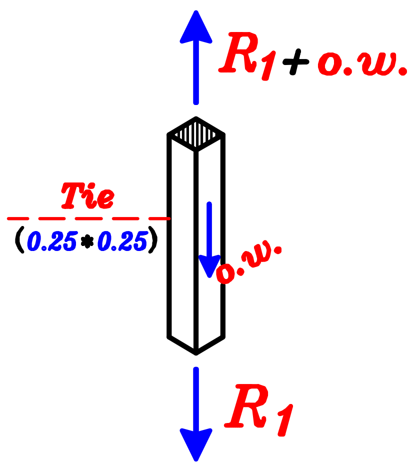
$R_1 = g_a * \text{Spacing} = 13.50 * 6.0 = 81.0 \ kN$ ------ D.L.

$= w_a * \text{Spacing} = 17.50 * 6.0 = 105 \ kN$ ------ T.L.

$$\boxed{\begin{array}{ll} R_1 = 81.0 \ kN & \text{----- D.L.} \\ \quad = 105 \ kN & \text{----- T.L.} \end{array}}$$



ينتقل ال reaction (R_1) من الكمره B_1 الى ال Tie
و منه الى ال Girder .



$o.w.(Tie) = (0.25 * 0.25 * 3.20) * 25$

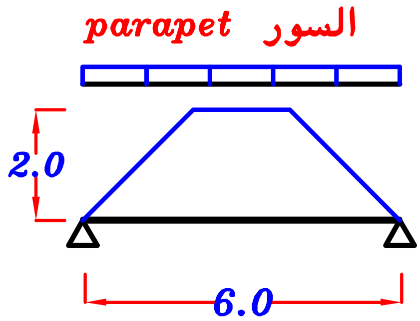
$= 5.0 \ kN$

B_2

For Trapezoid 1 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



السور

$$parapet = b * h * \gamma_{wall} = 0.25 * 1.20 * 15.0 = 4.50 \ kN/m`$$

Load For Shear.

$$g_a = O.W. + parapet + C_a \, g_s \frac{L_s}{2} = 3.5 + 4.5 + (0.67)(5.0)\left(\frac{4.0}{2}\right) = 14.70 \ kN\backslash m`$$

$$p_a = C_a \, p_{sh} \frac{L_s}{2} = (0.67)(2.0)\left(\frac{4.0}{2}\right) = 2.68 \ kN\backslash m`$$

$$w_a = g_a + p_a = 14.70 + 2.68 = 17.38 \ kN\backslash m`$$

$$R_2 = g_a * Spacing = 14.70 * 6.0 = 88.20 \ kN \text{ ----- D.L.}$$

$$= w_a * Spacing = 17.38 * 6.0 = 104.3 \ kN \text{ ----- T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 88.20 \ kN \text{ --- D.L.} \\ &= 104.3 \ kN \text{ --- T.L.} \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + parapet + C_e \, g_s \frac{L_s}{2} = 3.5 + 4.5 + (0.85)(5.0)\left(\frac{4.0}{2}\right) = 16.5 \ kN\backslash m`$$

$$p_e = C_e \, p_{sh} \frac{L_s}{2} = (0.85)(2.0)\left(\frac{4.0}{2}\right) = 3.40 \ kN\backslash m`$$

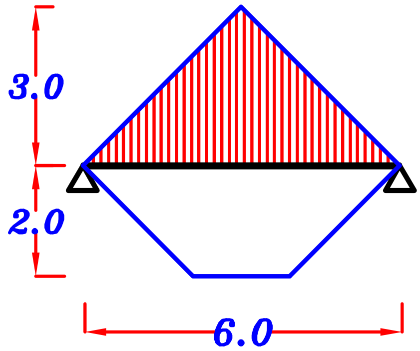
$$w_e = g_e + p_e = 16.5 + 3.40 = 19.90 \ kN\backslash m`$$

B_3

For Trapezoid 1 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



For triangle $C_a = \frac{1}{2}$ $C_e = \frac{2}{3}$

Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2}$$

$$= 3.5 + (0.67)(5.0)\left(\frac{4.0}{2}\right) + \left(\frac{1}{2}\right)(5.0)\left(\frac{6.0}{2}\right) = 17.70 \text{ kN}\backslash m'$$

$$p_a = C_a\, p_{sh} \frac{L_s}{2} + C_a\, p_{si} \frac{L_s}{2}$$

$$= (0.67)(2.0)\left(\frac{4.0}{2}\right) + \left(\frac{1}{2}\right)(1.82)\left(\frac{6.0}{2}\right) = 5.41 \text{ kN}\backslash m'$$

$$w_a = g_a + p_a = 17.70 + 5.41 = 23.11 \text{ kN}\backslash m'$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + C_e\, g_s \frac{L_s}{2}$$

$$= 3.5 + (0.85)(5.0)\left(\frac{4.0}{2}\right) + \left(\frac{2}{3}\right)(5.0)\left(\frac{6.0}{2}\right) = 22.0 \text{ kN}\backslash m'$$

$$p_e = C_e\, p_{sh} \frac{L_s}{2} + C_e\, p_{si} \frac{L_s}{2}$$

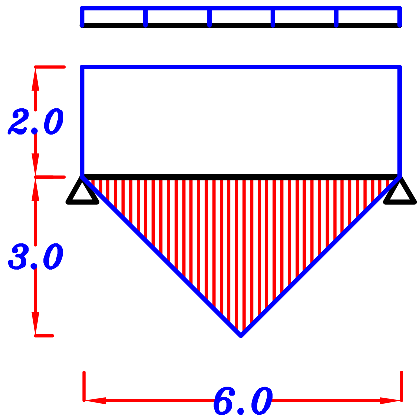
$$= (0.85)(2.0)\left(\frac{4.0}{2}\right) + \left(\frac{2}{3}\right)(1.82)\left(\frac{6.0}{2}\right) = 7.04 \text{ kN}\backslash m'$$

$$w_e = g_e + p_e = 22.0 + 7.04 = 29.04 \text{ kN}\backslash m'$$

B_4

السور

$$parapet = b * h * \gamma_{wall}$$
$$= 0.25 * 1.20 * 15.0 = 4.50 \ kN/m'$$



Load For Shear.

$$g_a = O.W. + parapet + g_s \ L_c + C_a \ g_s \frac{L_s}{2}$$
$$= 3.5 + 4.5 + (5.0)(2.0) + (\frac{1}{2})(5.0)(\frac{6.0}{2}) = 25.5 \ kN\backslash m'$$

$$p_a = p_{sh} \ L_c + C_a \ p_{si} \frac{L_s}{2}$$
$$= (2.0)(2.0) + (\frac{1}{2})(1.82)(\frac{6.0}{2}) = 6.73 \ kN\backslash m'$$

$$w_a = g_a + p_a = 25.5 + 6.73 = 32.23 \ kN\backslash m'$$

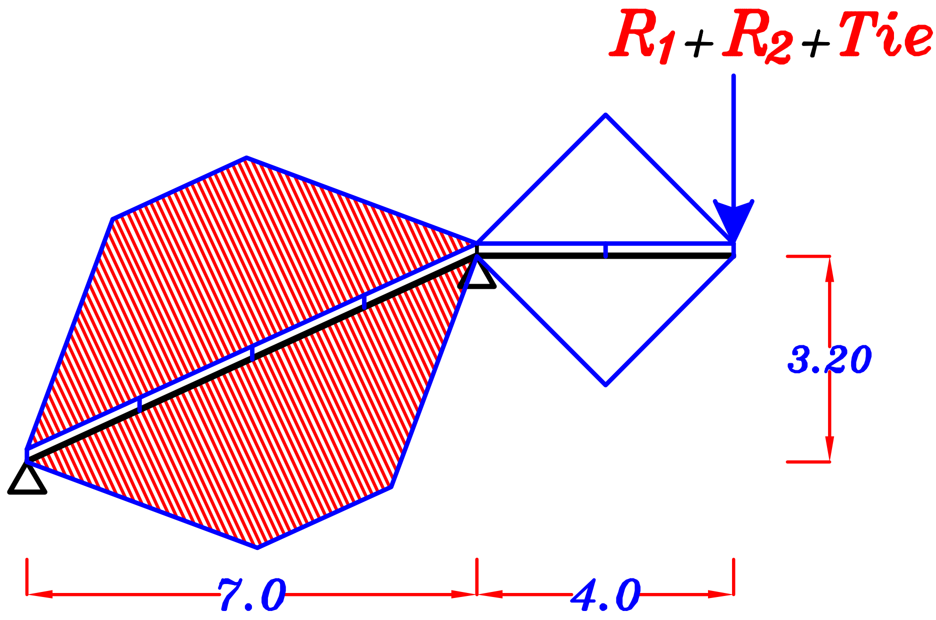
Load For Moment.

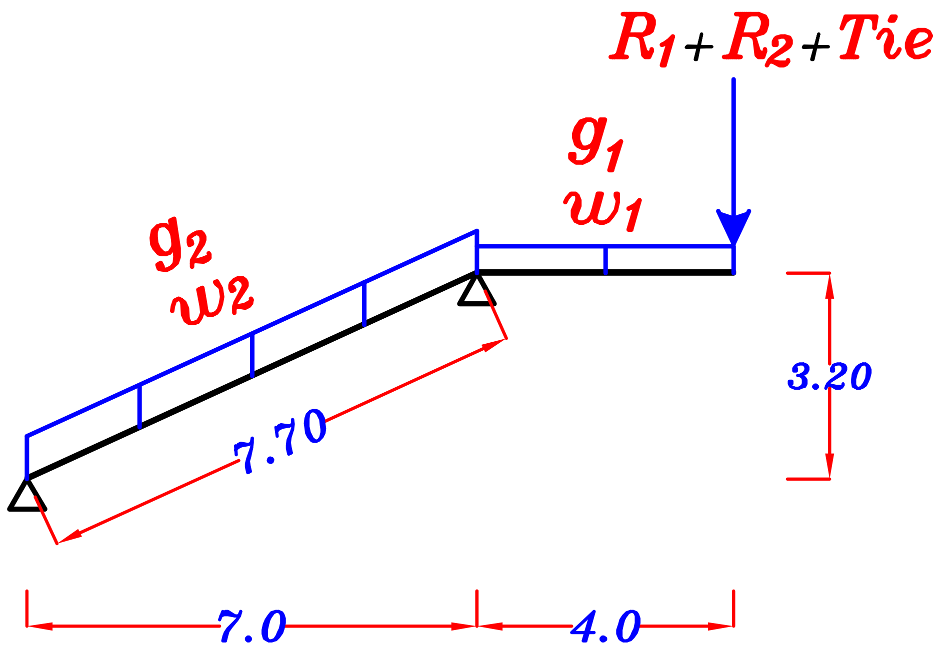
$$g_e = O.W. + parapet + g_s \ L_c + C_e \ g_s \frac{L_s}{2}$$
$$= 3.5 + 4.5 + (5.0)(2.0) + (\frac{2}{3})(5.0)(\frac{6.0}{2}) = 28.0 \ kN\backslash m'$$

$$p_e = p_{sh} \ L_c + C_e \ p_{si} \frac{L_s}{2}$$
$$= (2.0)(2.0) + (\frac{2}{3})(1.82)(\frac{6.0}{2}) = 7.64 \ kN\backslash m'$$

$$w_e = g_e + p_e = 28.0 + 7.64 = 35.64 \ kN\backslash m'$$

G





w_1

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{1}{2}$

Load For Shear. = Load For Moment.

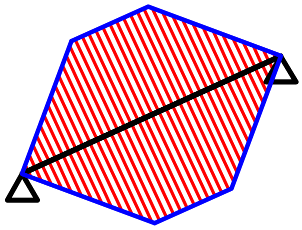
$$g_1 = O.W. + 2\,C_a\,g_s\,\frac{L_s}{2} = 3.50 + 2\left(\frac{1}{2}\right)(5.0)\left(\frac{4}{2}\right) = 13.5 \;\; kN\backslash m`$$

$$p_1 = 2\,C_a\,p_{sh}\,\frac{L_s}{2} = 2\left(\frac{1}{2}\right)(2.0)\left(\frac{4}{2}\right) = 4.0 \;\; kN\backslash m`$$

$$w_1 = g_1 + p_1 = 13.5 + 4.0 = 17.5 \;\; kN\backslash m`$$

w_2

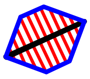
For Trapezoid 2 **Inclined**



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{6.0}{7.7}\right) = 0.61$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{6.0}{7.7}\right)^2 = 0.80$$

Load For Shear.

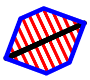


$$g_{2a} = O.W. + 2\,C_a\,g_s\,\frac{L_s}{2} = 3.50 + 2\,(0.61)\,(5.0)\left(\frac{6}{2}\right) = 21.80 \ \ kN\backslash m`$$

$$p_{2a} = 2\,C_a\,p_{si}\,\frac{L_s}{2} = 2\,(0.61)\,(1.82)\left(\frac{6}{2}\right) = 6.66 \ \ kN\backslash m`$$

$$w_{2a} = g_{2a} + p_{2a} = 21.80 + 6.66 = 28.46 \ \ kN\backslash m`$$

Load For Moment.



$$g_{2e} = O.W. + 2\,C_e\,g_s\,\frac{L_s}{2} = 3.50 + 2\,(0.80)\,(5.0)\left(\frac{6}{2}\right) = 27.50 \ \ kN\backslash m`$$

$$p_{2e} = 2\,C_e\,p_{si}\,\frac{L_s}{2} = 2\,(0.80)\,(1.82)\left(\frac{6}{2}\right) = 8.73 \ \ kN\backslash m`$$

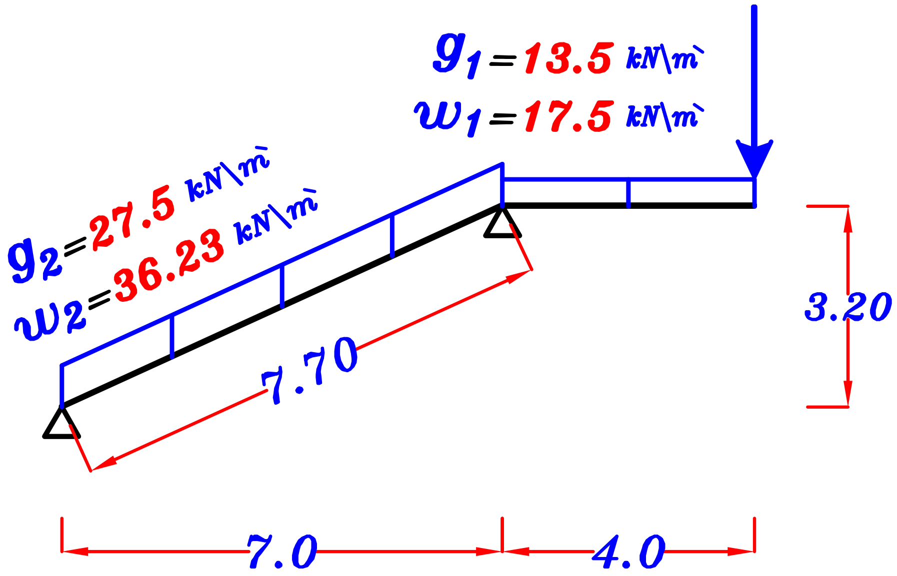
$$w_{2e} = g_{2e} + p_{2e} = 27.50 + 8.73 = 36.23 \ \ kN\backslash m`$$

3 – Draw the max–max bending moment diagram For girder G using Ultimate limits loads.

$R_1 + R_2 + Tie$

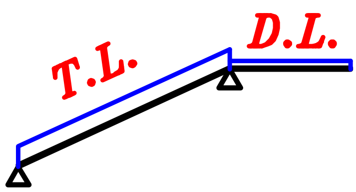
D.L. 81.0 + 88.20 + 5.0 = 174.2

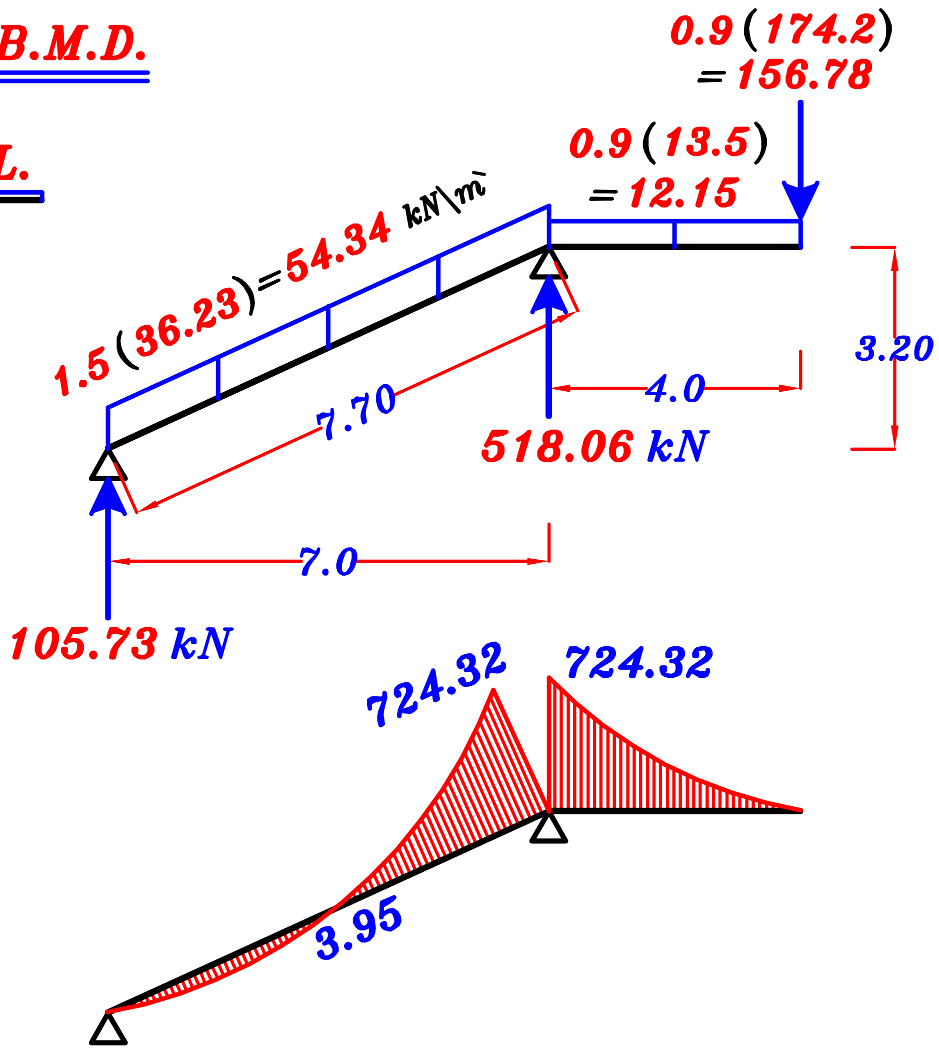
T.L. 105 + 104.3 + 5.0 = 214.3



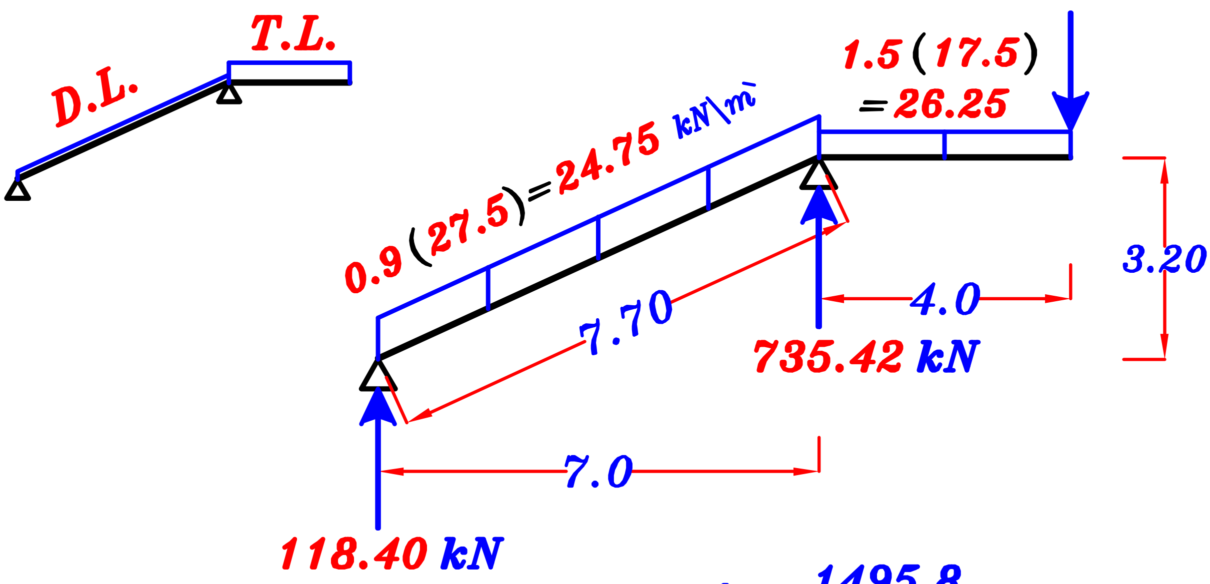
max–max B.M.D. For the Girder.

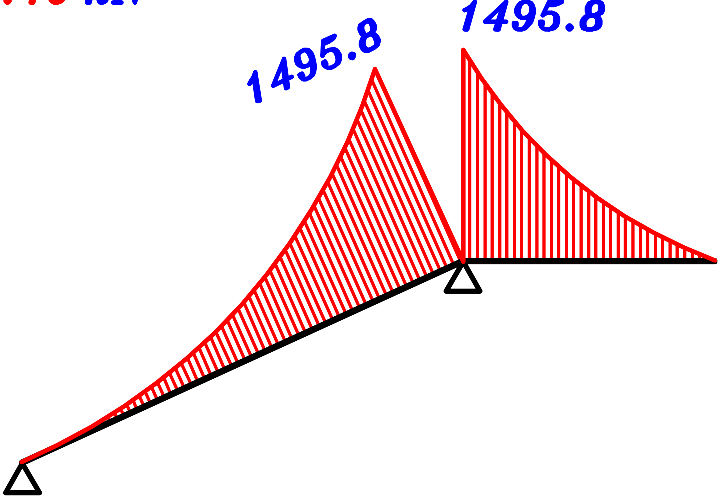
1– max. +ve B.M.D.



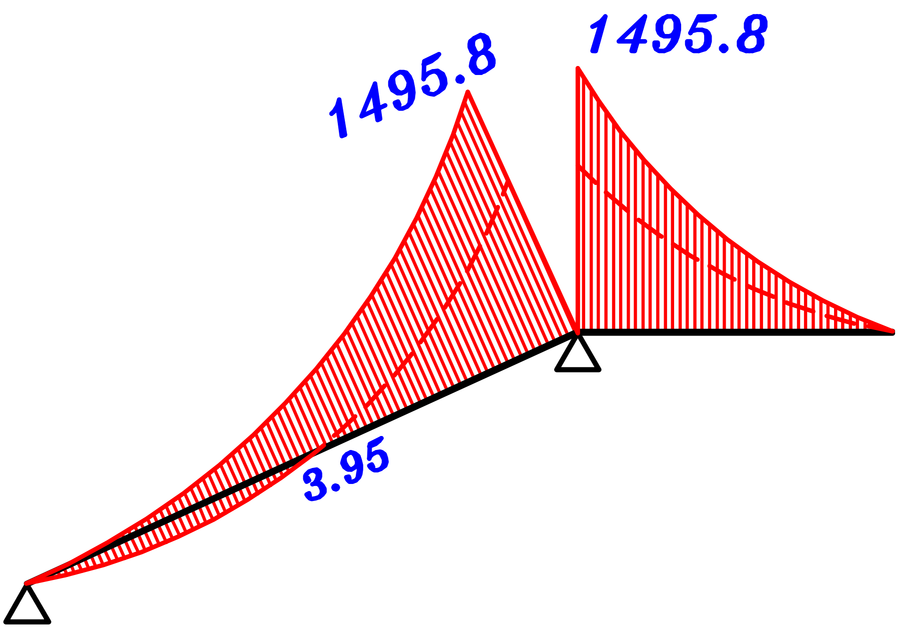


2- max. −ve B.M.D.

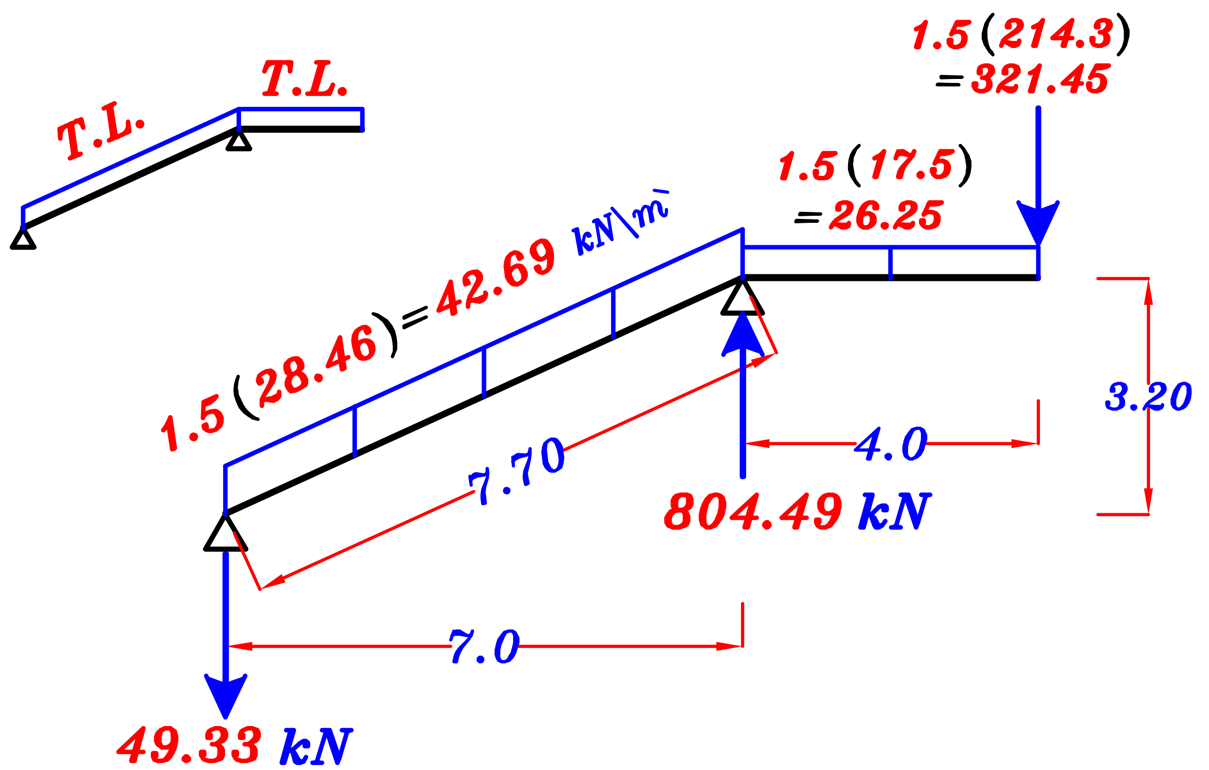


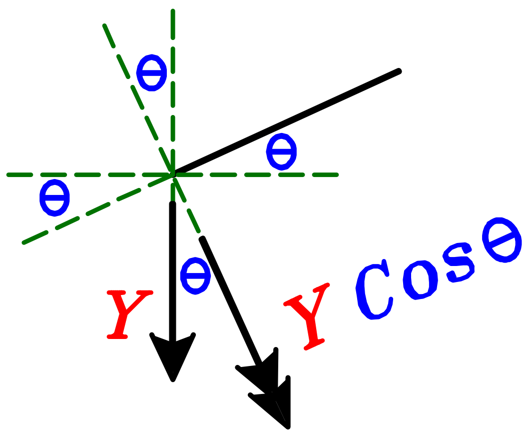


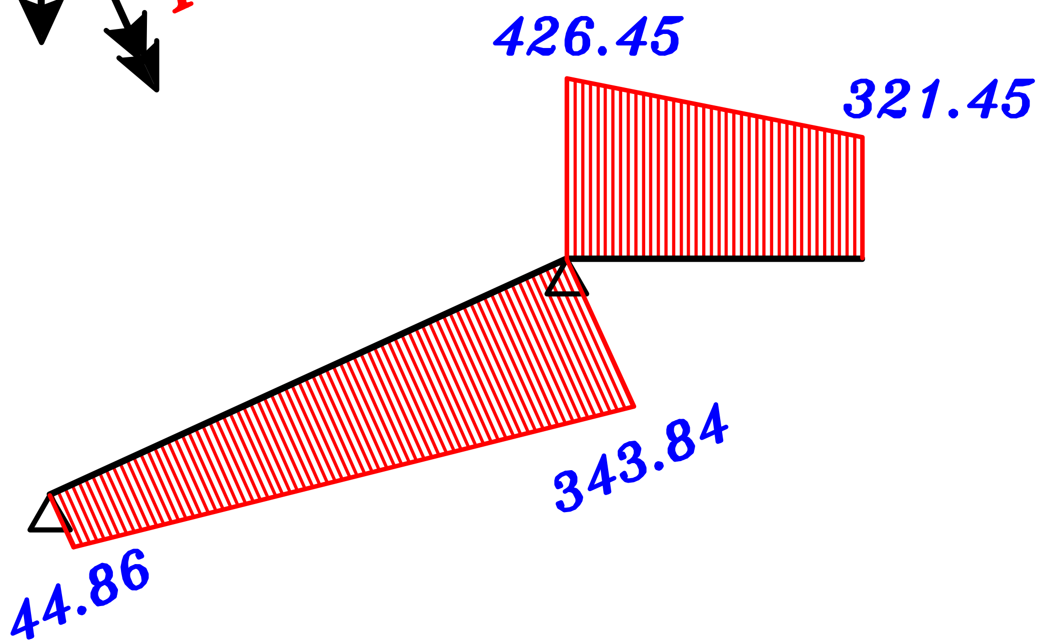
max−max B.M.D. For the Girder.



4- Draw the shearing Force diagram For the case of total load only For girder G.

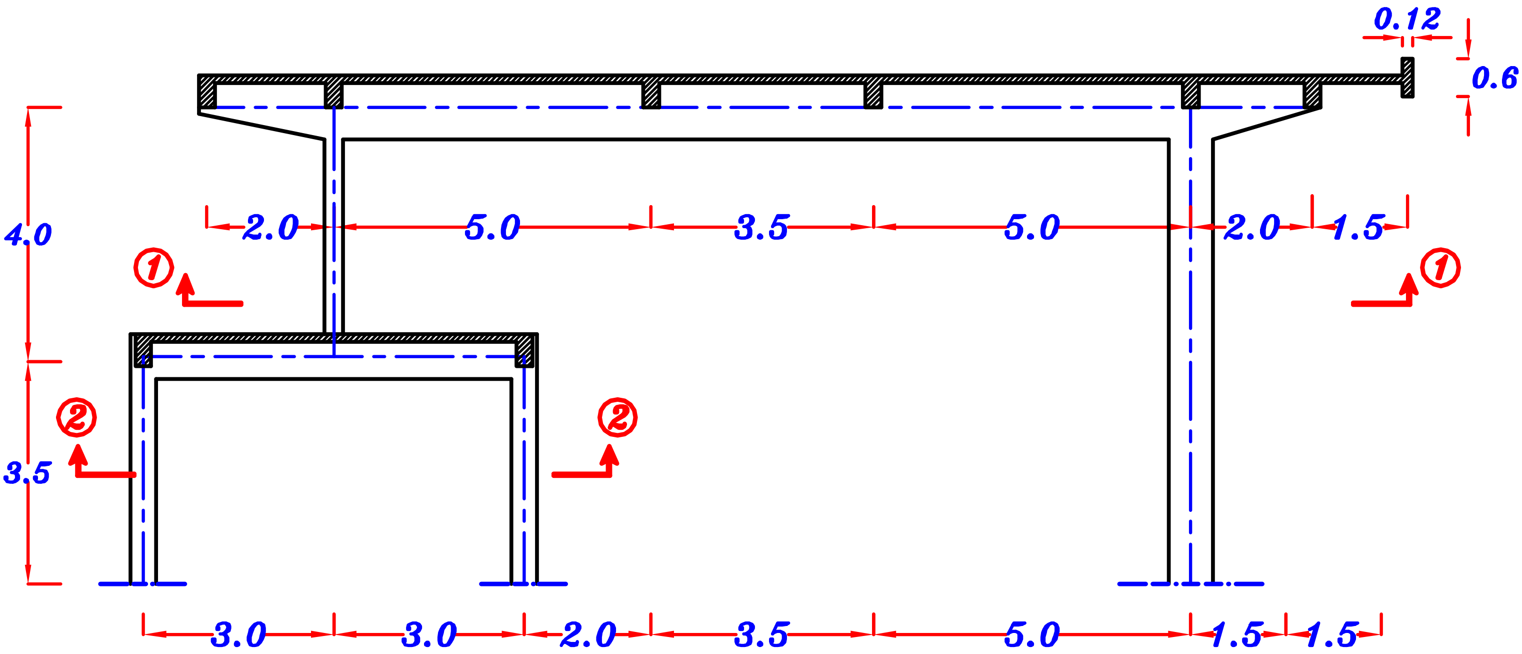






S.F.D.

Example.



Data.

$t_s = 0.12\ m$

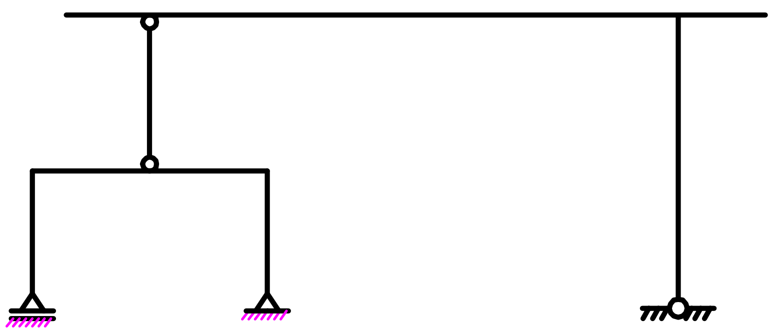
$F.C. = 2.0 \quad kN\backslash m^2$

$L.L. = 2.50 \quad kN\backslash m^2$

b (beam) $= 0.25\ m$

b (Frame) $= 0.35\ m$

Spacing $= 6.0\ m$



Statical System

Req.

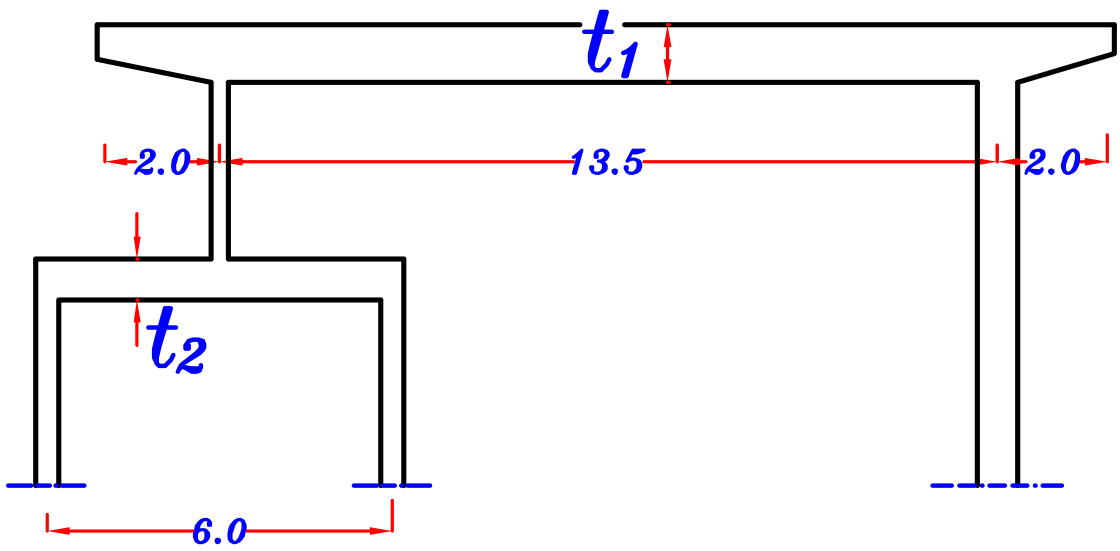
1 – Estimate the concrete dimensions and own weight of the beams and Frame.

2 – Draw plans ① & ② illustrate the pattern of load distribution.

3 – Draw N.F.D. & S.F.D. (case of total load only) For the Frame.

4 – Draw max–max B.M.D. For the Frame.

1 – Estimate the concrete dimensions and own weight of the beams and Frame.



$$t_{secondary\ beams} = \frac{spacing}{12} = \frac{6.0}{12} = 0.50\ m$$

upper Frame $t_1 = \frac{13.5}{12} = 1.125\ m$

$\quad = \frac{2.0}{5} = 0.40\ m$

$\Big\} = 1.125\ m = 1.15\ m$

lower Frame $t_2 = \frac{6.0}{10} = 0.60\ m$

---

o.w. of Beams & Frames $= b\ t\ \gamma_c$

Beams $(250 * 500)$ o.w. $= (0.25)\ (0.5)\ (25) = 3.12\ kN\backslash m'$

upper Frame (F_1) $(350 * 1150)$ o.w. $= (0.35)\ (1.15)\ (25) = 10.0\ kN\backslash m'$

lower Frame (F_2) $(350 * 600)$ o.w. $= (0.35)\ (0.60)\ (25) = 5.25\ kN\backslash m'$

---

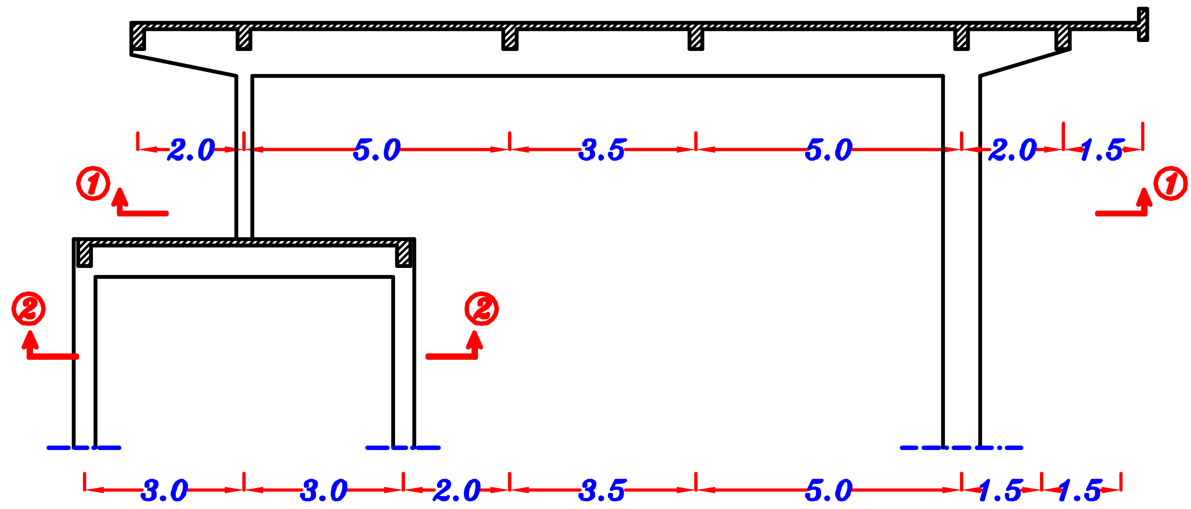
g_s , p_s

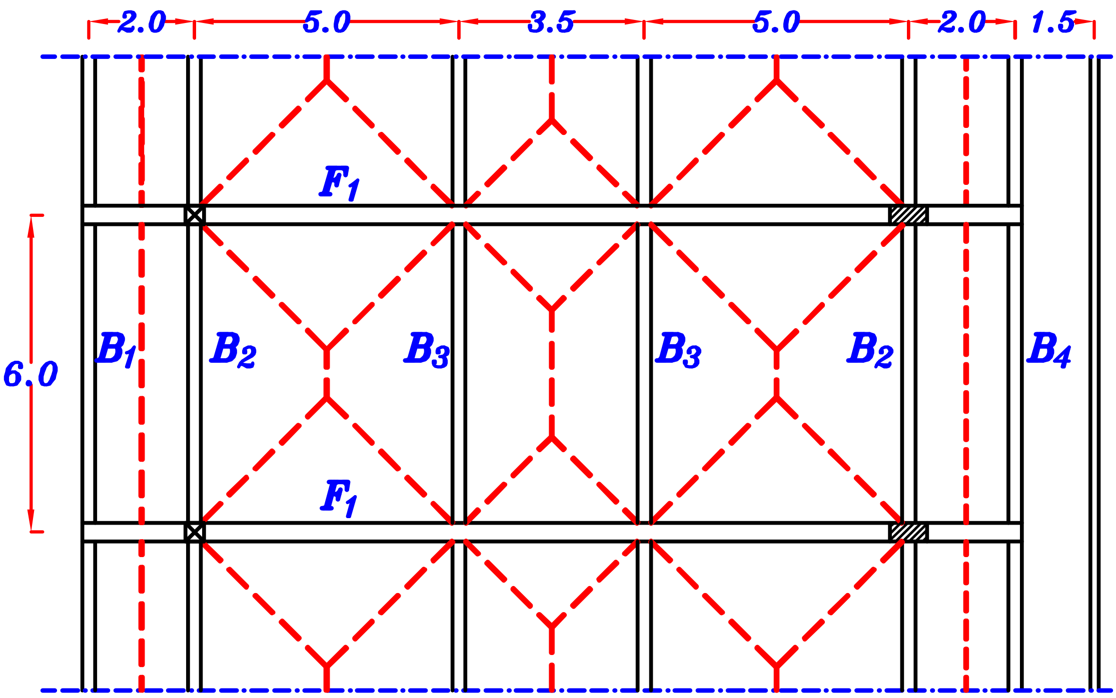
$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 2.0 = 5.0\ kN\backslash m^2$$

$$p_s = L.L. = 2.50\ kN\backslash m^2$$

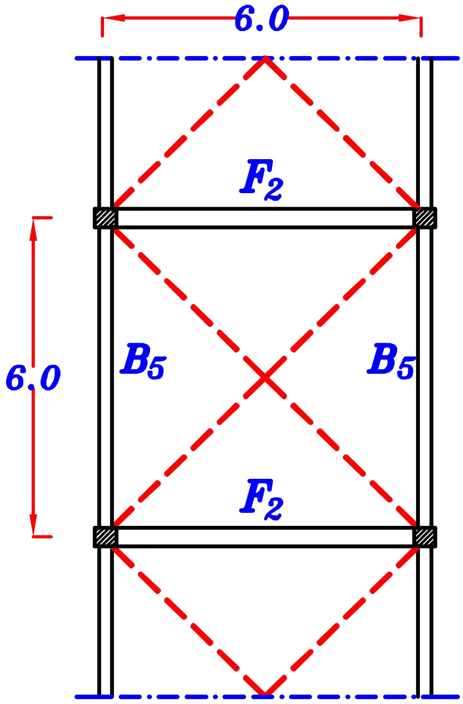
$\boxed{g_s = 5.0\ kN\backslash m^2}$, $\boxed{p_s = 2.50\ kN\backslash m^2}$

2 – Draw plans ① & ② illustrate the pattern of load distribution.





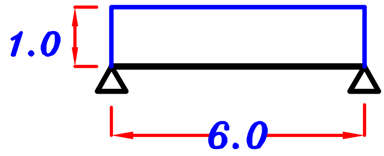
Plan ①



Plan ②

B_1

$$g_a = O.W. + g_s \frac{L_s}{2} = 3.12 + (5.0)\left(\frac{2}{2}\right) = 8.12 \text{ kN}\backslash m'$$



$$p_a = p_s \frac{L_s}{2} = (2.50)\left(\frac{2}{2}\right) = 2.50 \text{ kN}\backslash m'$$

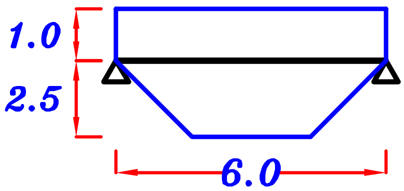
$$w_a = g_a + p_a = 8.12 + 2.50 = 10.62 \text{ kN}\backslash m'$$

$$R_1 = g_a * Spacing = 8.12 * 6.0 = 48.72 \text{ kN} \text{ ---- D.L.}$$

$$= w_a * Spacing = 10.62 * 6.0 = 63.72 \text{ kN} \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_1 &= 48.72 \text{ kN ---- D.L.} \\ &= 63.72 \text{ kN ---- T.L.} \end{aligned}}$$

B_2



For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5}{6}\right) = 0.583$

$$g_a = O.W. + g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2} = 3.12 + (5.0)\left(\frac{2}{2}\right) + 0.583\,(5.0)\left(\frac{5}{2}\right) = 15.4 \text{ kN}\backslash m'$$

$$p_a = p_s \frac{L_s}{2} + C_a\, p_s \frac{L_s}{2} = (2.50)\left(\frac{2}{2}\right) + 0.583\,(2.50)\left(\frac{5}{2}\right) = 6.14 \text{ kN}\backslash m'$$

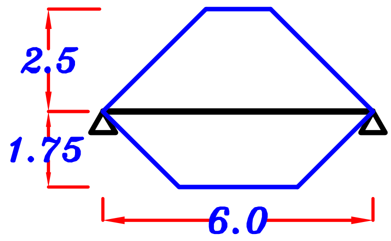
$$w_a = g_a + p_a = 15.4 + 6.14 = 21.54 \text{ kN}\backslash m'$$

$$R_2 = g_a * Spacing = 15.4 * 6.0 = 92.40 \text{ kN} \text{ ---- D.L.}$$

$$= w_a * Spacing = 21.54 * 6.0 = 129.2 \text{ kN} \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 92.40 \text{ kN ---- D.L.} \\ &= 129.2 \text{ kN ---- T.L.} \end{aligned}}$$

B_3



For Trapezoid ① $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5}{6}\right) = 0.583$

For Trapezoid ② $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.5}{6}\right) = 0.708$

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2} = 3.12 + 0.583\,(5.0)\left(\frac{5}{2}\right) + 0.708\,(5.0)\left(\frac{3.5}{2}\right) = 16.6 \text{ kN}\backslash m'$$

$$p_a = C_a\, p_s \frac{L_s}{2} + C_a\, p_s \frac{L_s}{2} = 0.583\,(2.50)\left(\frac{5}{2}\right) + 0.708\,(2.50)\left(\frac{3.5}{2}\right) = 6.74 \text{ kN}\backslash m'$$

$$w_a = g_a + p_a = 16.6 + 6.74 = 23.34 \text{ kN}\backslash m'$$

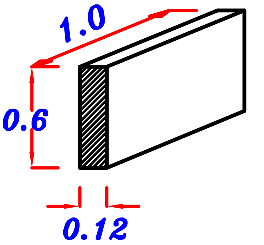
$$R_3 = g_a * Spacing = 16.6 * 6.0 = 99.6 \text{ kN} \text{ ---- D.L.}$$

$$= w_a * Spacing = 23.34 * 6.0 = 140 \text{ kN} \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_3 &= 99.6 \text{ kN ---- D.L.} \\ &= 140 \text{ kN ---- T.L.} \end{aligned}}$$

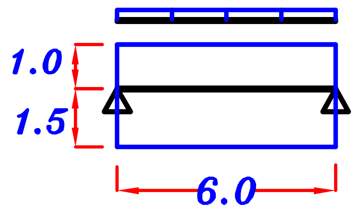
B_4

$$O.W.\ of\ the\ Fence = (0.12)(0.6)(1.0)(25) = 1.80\ kN\backslash m$$



$$g_a = O.W.(beam) + O.W.(Fence) + g_s\frac{L_s}{2} + g_s\ L_c$$

$$= 3.12 + 1.80 + (5.0)\left(\frac{2}{2}\right) + (5.0)(1.5) = 17.42\ kN\backslash m`$$



$$p_a = p_s\frac{L_s}{2} + p_s\ L_c = (2.50)\left(\frac{2}{2}\right) + (2.50)(1.5) = 6.25\ kN\backslash m`$$

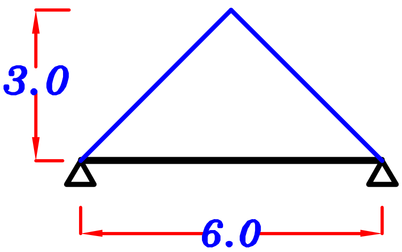
$$w_a = g_a + p_a = 17.42 + 6.25 = 23.67\ kN\backslash m`$$

$$R_4 = g_a * Spacing = 17.42 * 6.0 = 104.5\ kN \text{------}\ D.L.$$

$$= w_a * Spacing = 23.67 * 6.0 = 142.0\ kN \text{------}\ T.L.$$

$$\boxed{\begin{aligned} R_4 &= 104.5\ kN \text{------}\ D.L. \\ &= 142.0\ kN \text{------}\ T.L. \end{aligned}}$$

B_5



For Triangle

$$C_a = \frac{1}{2}\ ,\quad C_e = \frac{2}{3}$$

$$g_a = O.W. + \overset{\triangle}{C_a}\ g_s\frac{L_s}{2} = 3.12 + + \left(\frac{1}{2}\right)(5.0)\left(\frac{6.0}{2}\right) = 10.6\ kN\backslash m`$$

$$p_a = C_a\ p_s\frac{L_s}{2} = \left(\frac{1}{2}\right)(2.50)\left(\frac{6.0}{2}\right) = 3.75\ kN\backslash m`$$

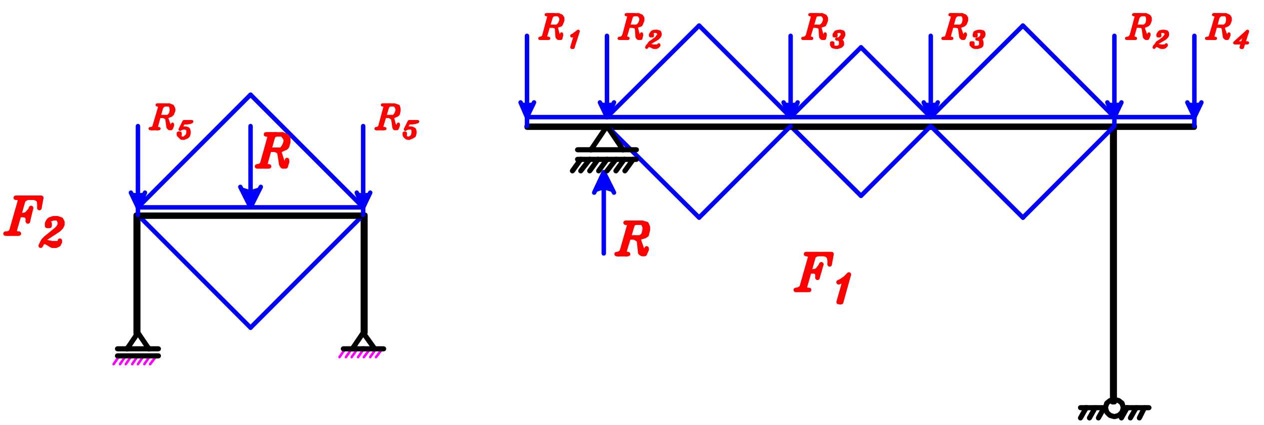
$$w_a = g_a + p_a = 10.6 + 3.75 = 14.35\ kN\backslash m`$$

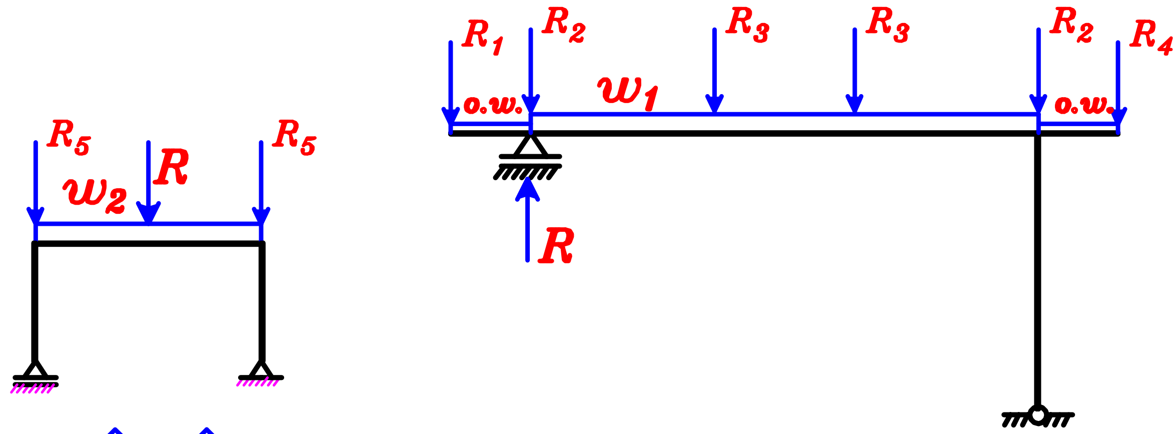
$$R_5 = g_a * Spacing = 10.6 * 6.0 = 63.6\ kN \text{------}\ D.L.$$

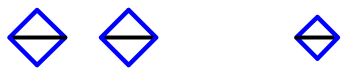
$$= w_a * Spacing = 14.35 * 6.0 = 86.1\ kN \text{------}\ T.L.$$

$$\boxed{\begin{aligned} R_5 &= 63.6\ kN \text{------}\ D.L. \\ &= 86.1\ kN \text{------}\ T.L. \end{aligned}}$$

Loads on the Frame.







$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}\right)(5.0)(2.5) + 2\left(\frac{1}{2}\right)(3.5)(1.75)}{13.5} = \mathbf{2.305}$$

w_1 **Load For shear = Load For Moment**

$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 10.0 + (2.305)(5.0) = \mathbf{21.52}\ kN\backslash m'$$

$$p_1 = \frac{\sum area}{span} * p_s = (2.305)(2.50) = \mathbf{5.76}\ kN\backslash m'$$

$$w_1 = g_1 + p_1 = 21.52 + 5.76 = \mathbf{27.28}\ kN\backslash m'$$

w_2

$$g_a = O.W. + 2\, C_a\, g_s\, \frac{L_s}{2} = 5.25 + 2\left(\frac{1}{2}\right)(5.0)\left(\frac{6}{2}\right) = \mathbf{20.25}\ kN\backslash m'$$

$$p_a = 2\, C_a\, p_s\, \frac{L_s}{2} = 2\left(\frac{1}{2}\right)(2.50)\left(\frac{6}{2}\right) = \mathbf{7.50}\ kN\backslash m'$$

$$w_a = g_a + p_a = 20.25 + 7.50 = \mathbf{27.75}\ kN\backslash m'$$

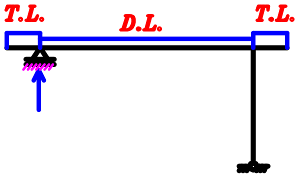
$$g_e = O.W. + 2\, C_e\, g_s\, \frac{L_s}{2} = 5.25 + 2\left(\frac{2}{3}\right)(5.0)\left(\frac{6}{2}\right) = \mathbf{25.35}\ kN\backslash m'$$

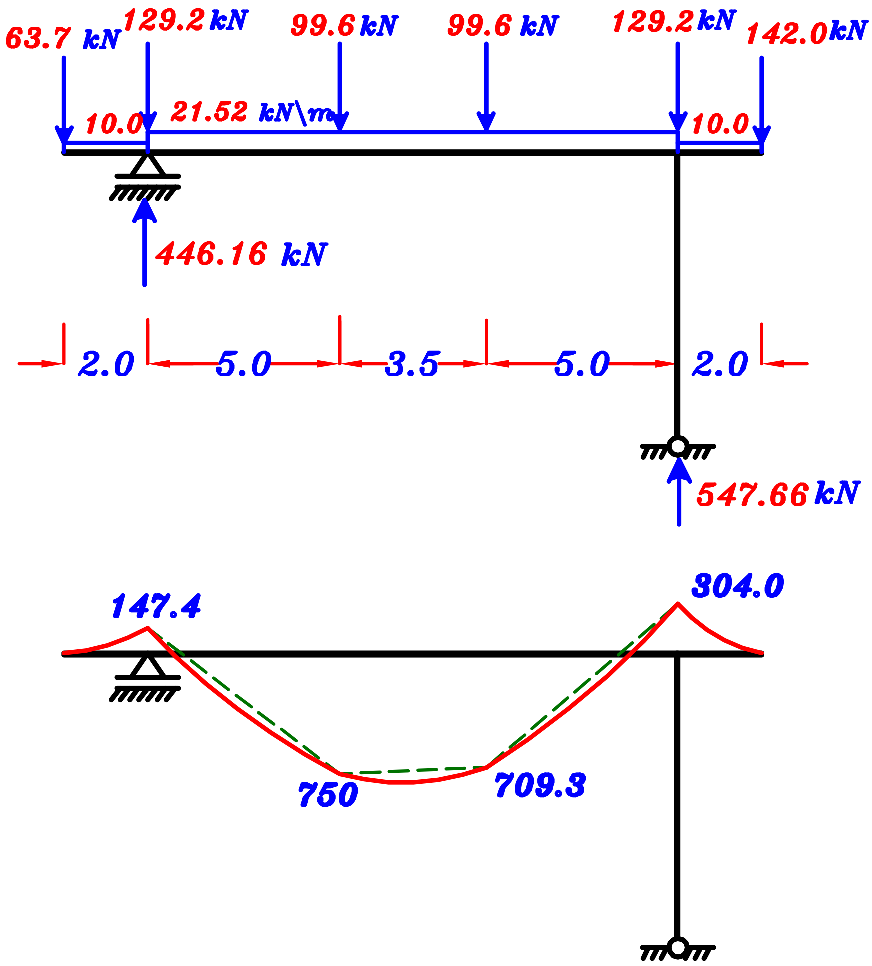
$$p_e = 2\, C_e\, p_s\, \frac{L_s}{2} = 2\left(\frac{2}{3}\right)(2.50)\left(\frac{6}{2}\right) = \mathbf{10.0}\ kN\backslash m'$$

$$w_e = g_e + p_e = 25.35 + 10.0 = \mathbf{35.35}\ kN\backslash m'$$

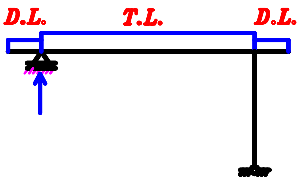
max–max B.M.D. on Frame (F_1)

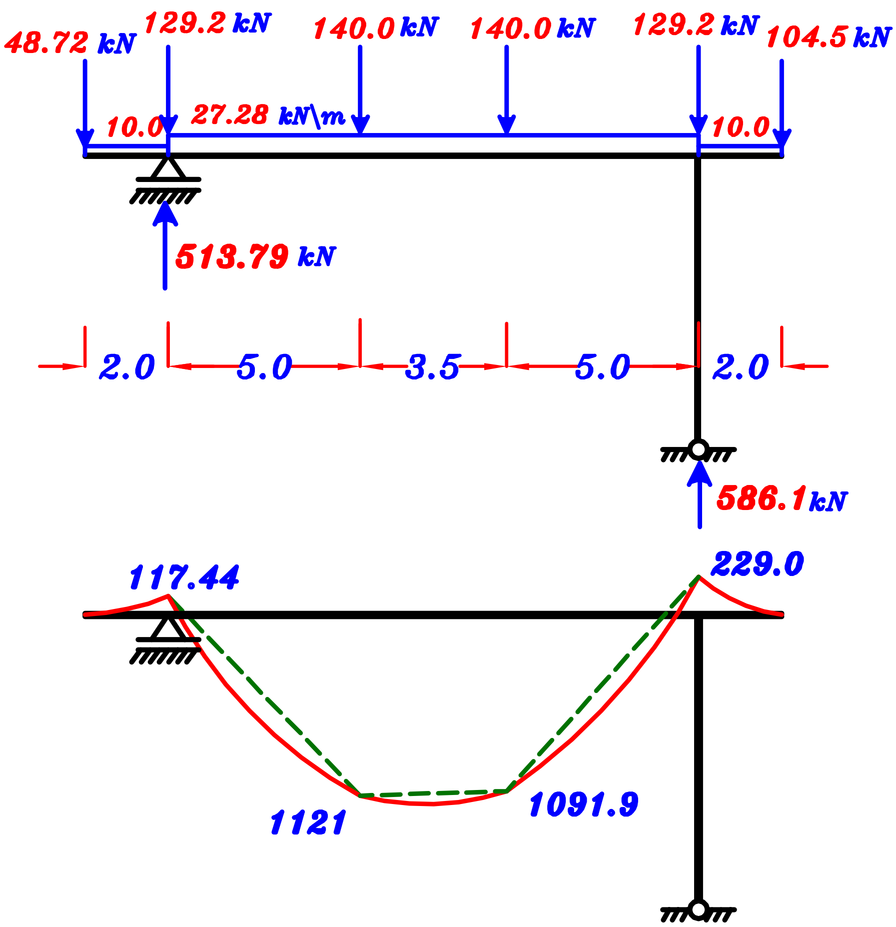
1- max. –ve B.M.D.



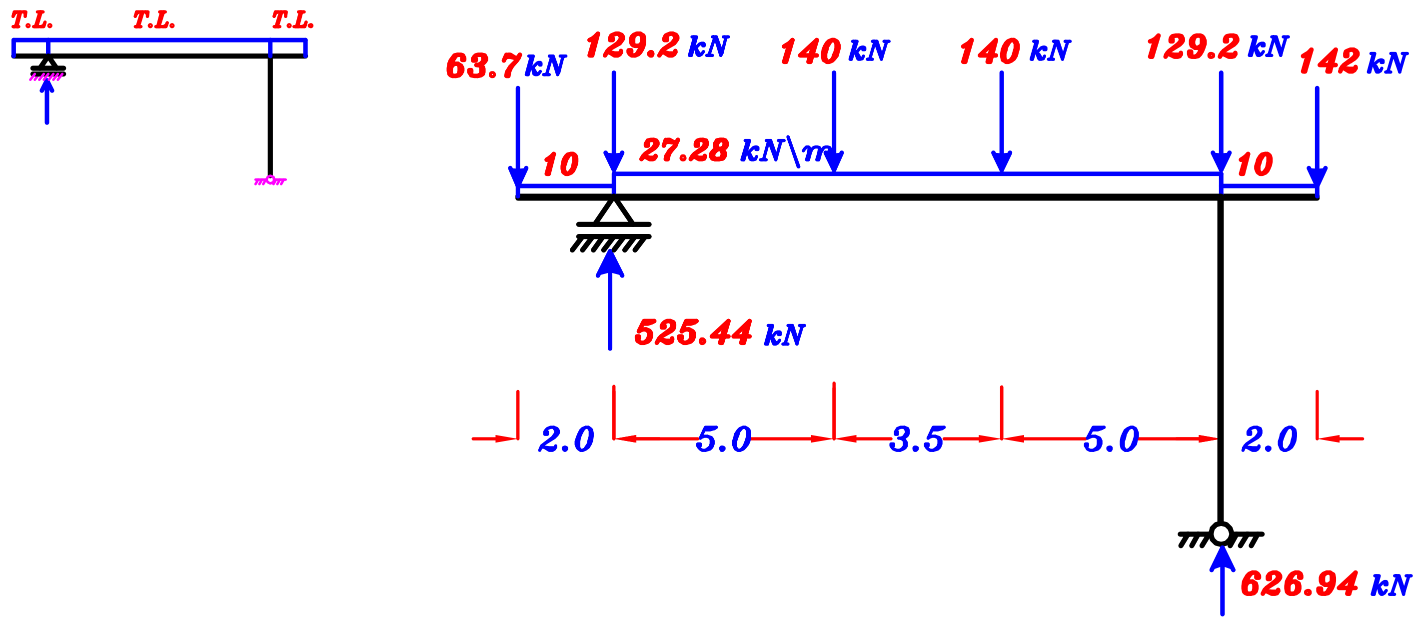


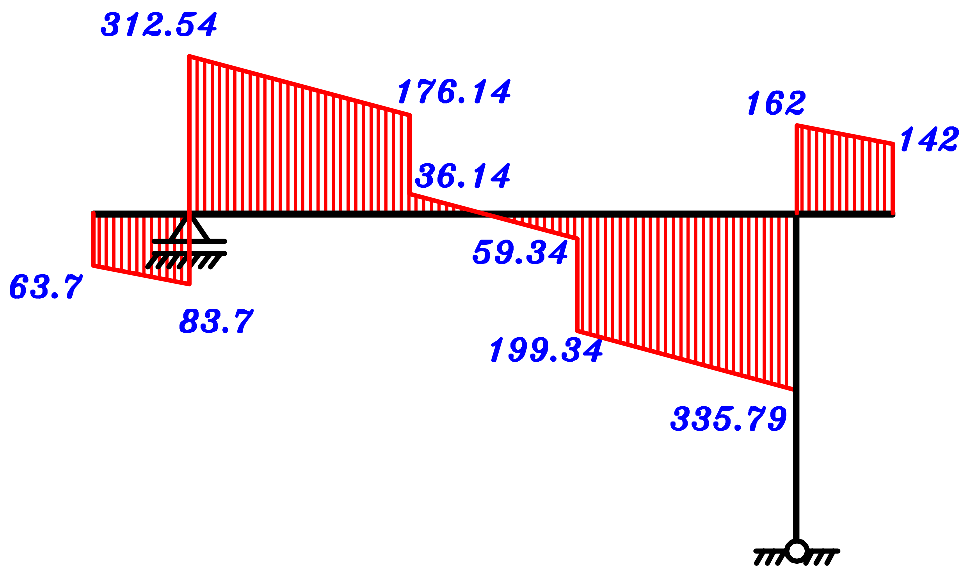
2- max. +ve B.M.D.





max-max S.F.D. & N.F.D. For Frame (F_1)

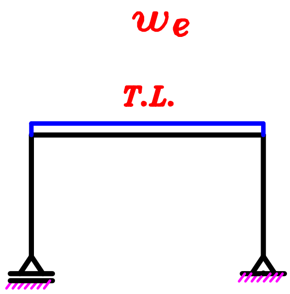


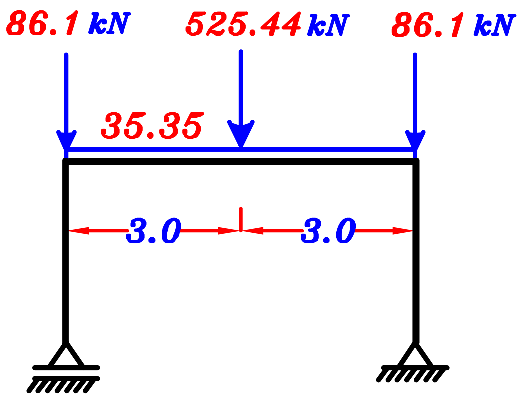


S.F.D.

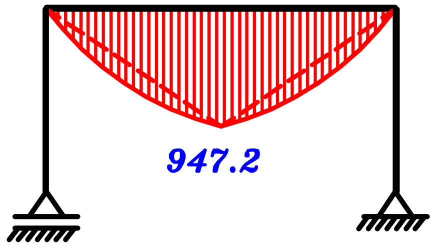
N.F.D.

max–max B.M.D. on Frame (F2)

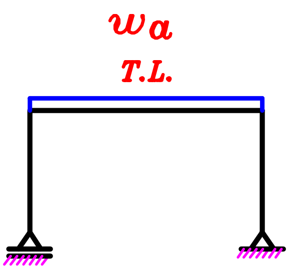


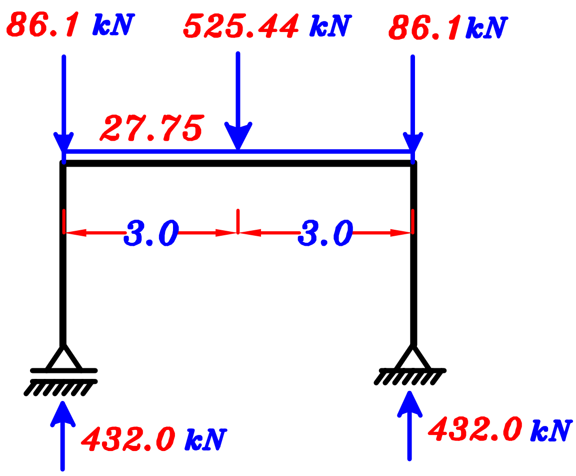


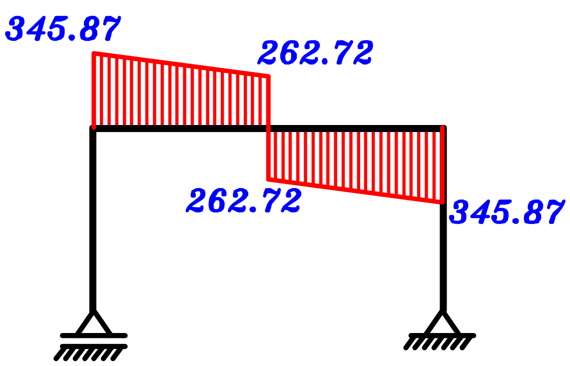
B.M.D.



max–max S.F.D. & N.F.D. For Frame (F2)

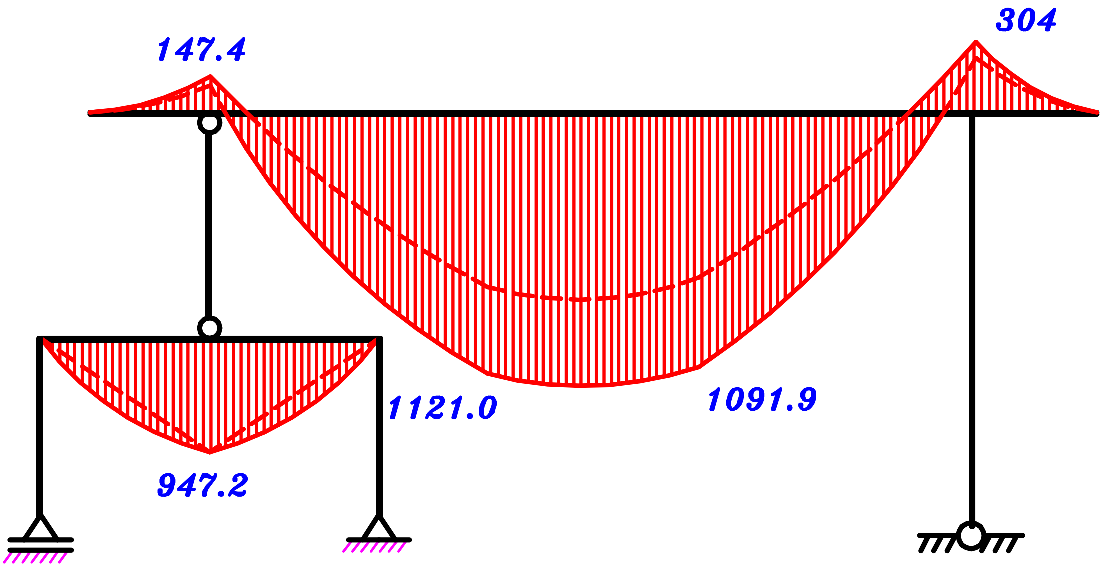




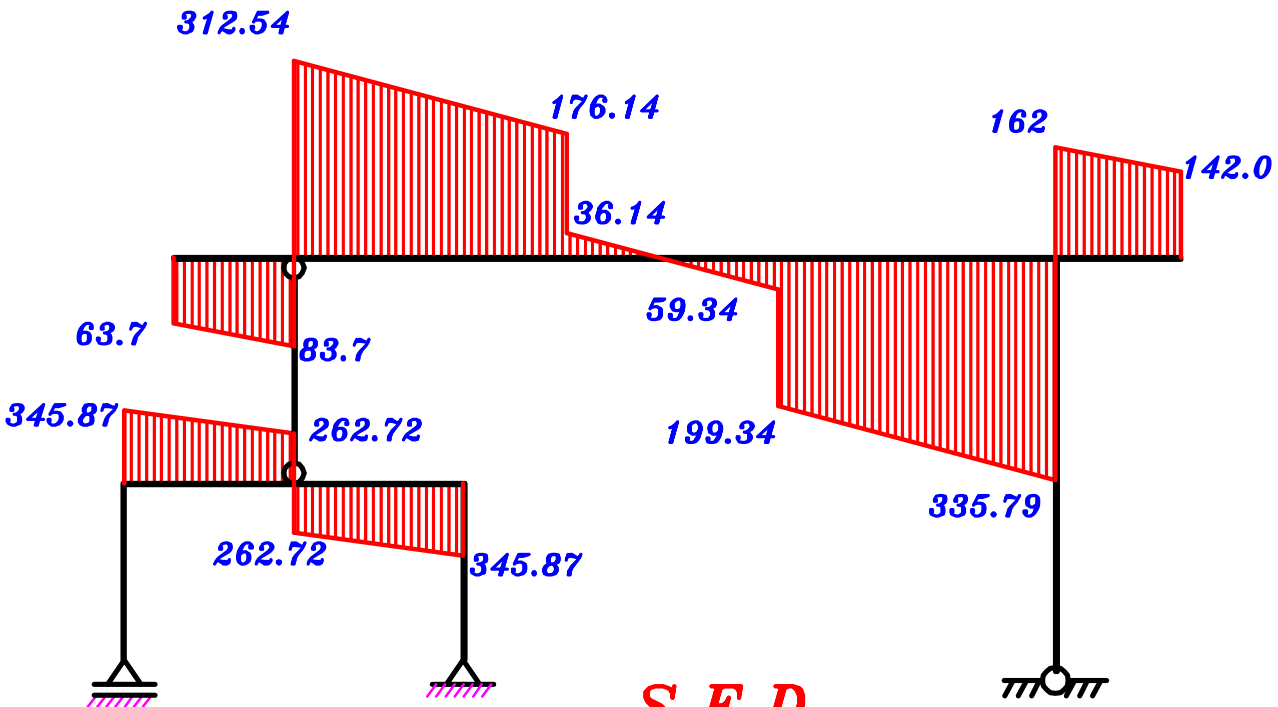


S.F.D.

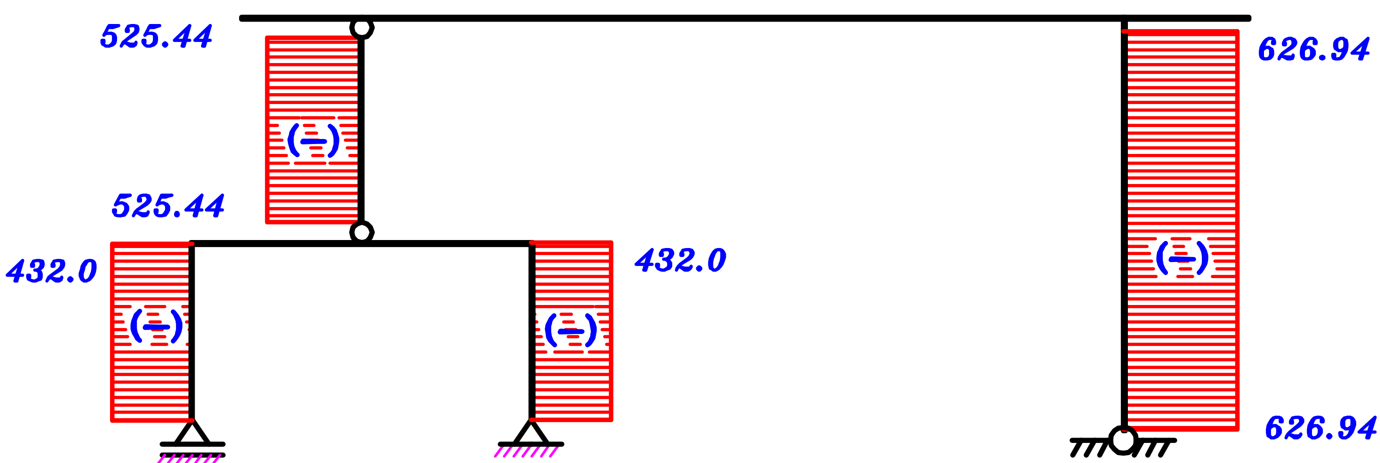
N.F.D.


147.4
304
1121.0
1091.9
947.2

B.M.D.


312.54
176.14
162
142.0
36.14
63.7
83.7
59.34
345.87
262.72
199.34
335.79
262.72
345.87

S.F.D.


525.44
626.94
(−)
525.44
432.0
432.0
(−)
(−)
(−)
626.94

N.F.D.

Example.

Figure 1 shows a sectional elevation of a reinforced concrete roof. The roof is covered by reinforced concrete slabs supported by a system of secondary beams and Frames (**F**) spaced at **6.0 m** For an intermediate panel, it is required to :

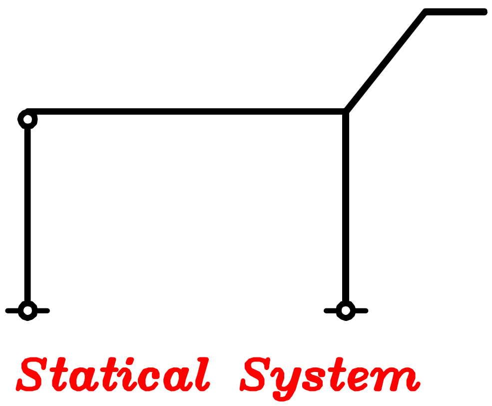
1- Draw a structural plan showing the pattern of load distribution.

2- Calculate the equivalent working loads For shear and moment For all secondary beams (B_1 , B_2 , B_3 , B_4 & B_5) and an intermediate Frame (**F**) .

3- Draw the **N.F.D.** (total load) , **S.F.D.** (total load) and **max-max B.M.D.** For an intermediate Frame (**F**) , **using ultimate limit loads.**

Data:

- Slab thickness t_s = 140 mm
- Live load = 2.0 kN\m^2 HL. projection.
- Floor cover = 1.0 kN\m^2
- Own weight of beams = 3.0 kN\m
- Own weight of Frame = 6.0 kN\m



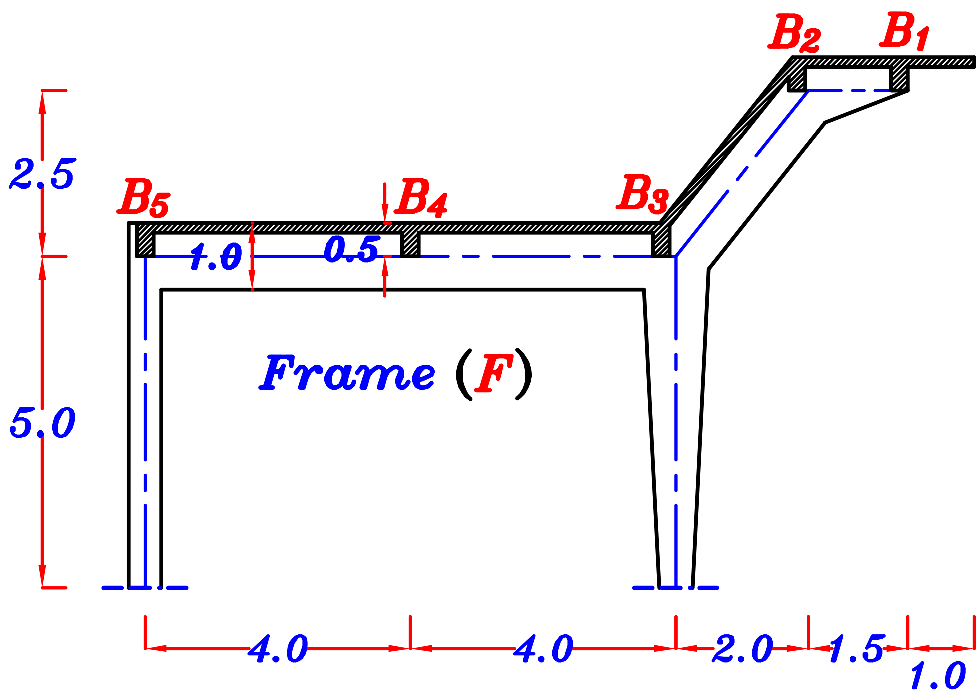


Figure 1

1- *Draw a structural plan showing the pattern of load distribution.*

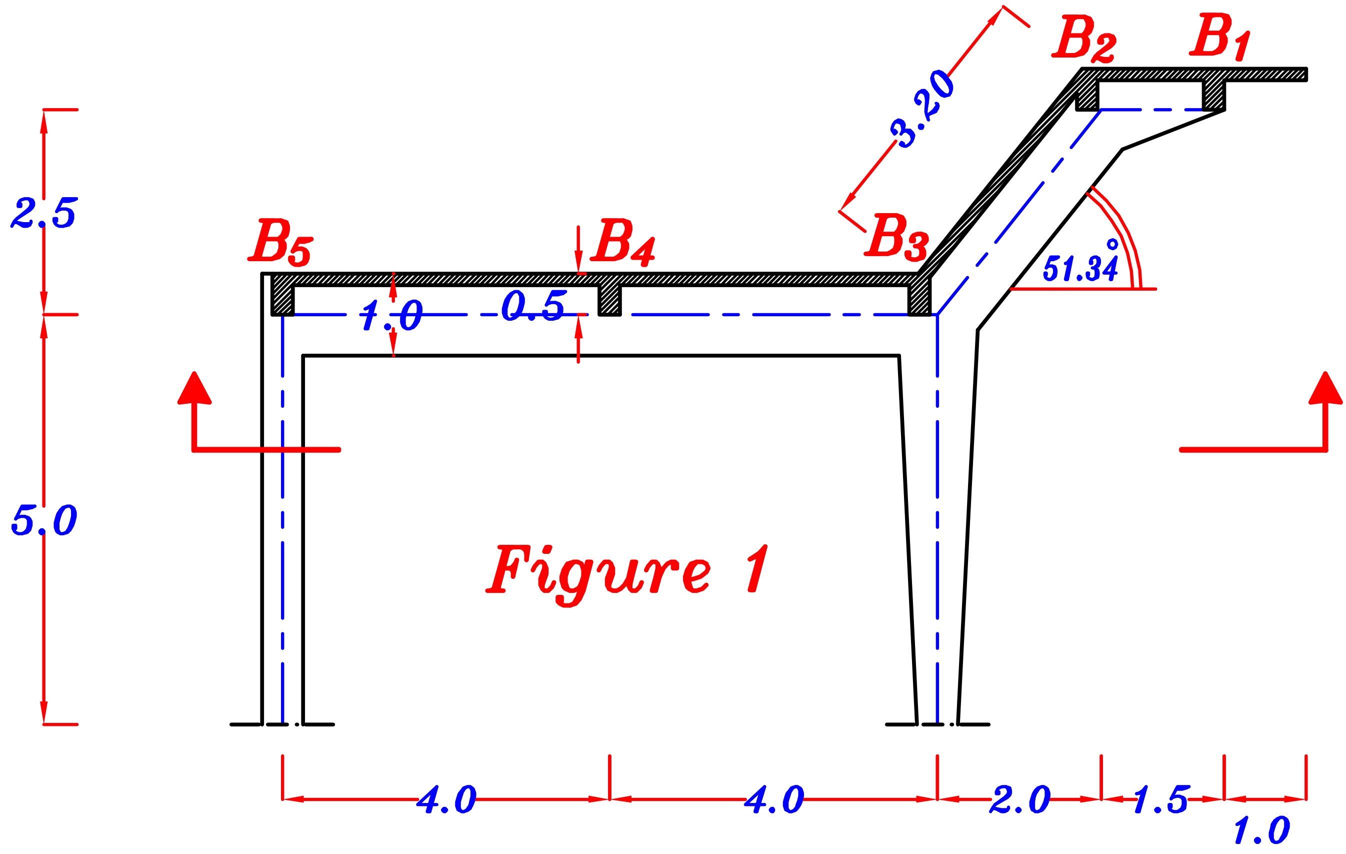
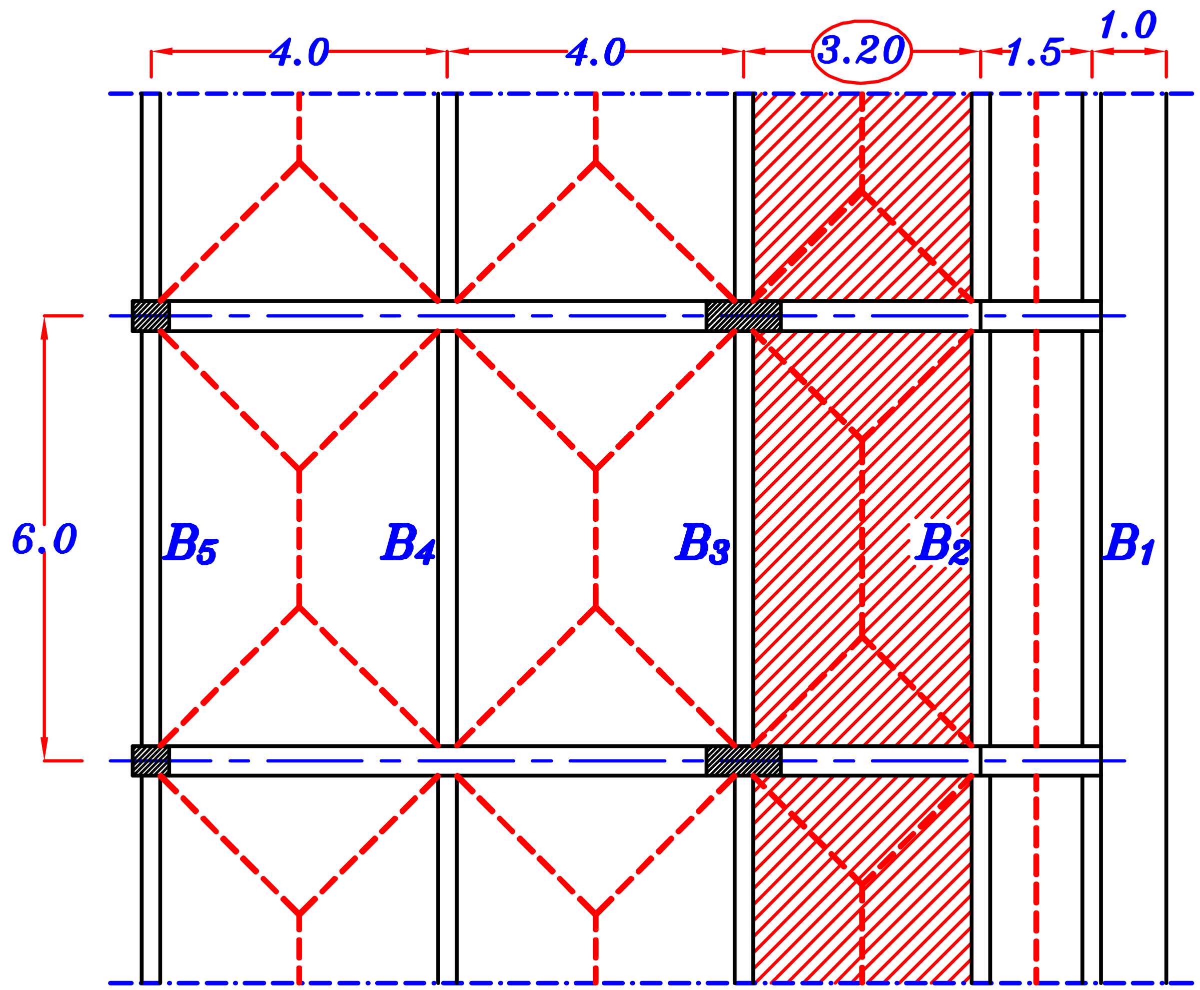


Figure 1



Plan

2- *Calculate the equivalent working loads For shear and moment For all secondary beams (B_1, B_2, B_3, B_4 & B_5) and an intermediate Frame (F).*

g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.0 = 4.50 \ kN\backslash m^2$$

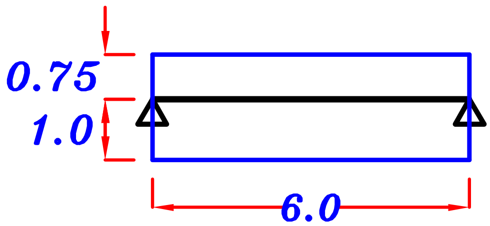
$$p_{sh} = L.L. = 2.0 \ kN\backslash m^2 \quad \text{------ HL. Slab.}$$

$$p_{si} = L.L. * \cos\theta = 2.0 * \cos 51.34^{\circ} = 1.25 \ kN\backslash m^2 \quad \text{----- Inclined Slab.}$$

$\boxed{g_s = 4.50 \ kN\backslash m^2}$, $\boxed{p_{sh} = 2.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 1.25 \ kN\backslash m^2}$

B_1

Load For Shear. = Load For Moment.



$$g_a = O.W. + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.0 + (4.50)\left(\frac{1.5}{2}\right) + (4.50)(1.0)$$

$$= 10.875 \ kN\backslash m'$$

$$p_a = p_{sh} \frac{L_s}{2} + p_{sh} L_c = (2.0)\left(\frac{1.5}{2}\right) + (2.0)(1.0) = 3.5 \ kN\backslash m'$$

$$w_a = g_a + p_a = 10.875 + 3.5 = 14.375 \ kN\backslash m'$$

$$R_1 = g_a * Spacing = 10.875 * 6.0 = 65.25 \ kN \quad \text{----- D.L.}$$

$$= w_a * Spacing = 14.375 * 6.0 = 86.25 \ kN \quad \text{----- T.L.}$$

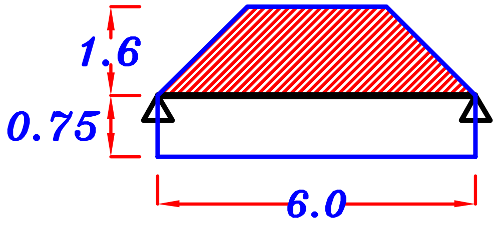
$$\boxed{\begin{aligned} R_1 &= 65.25 \ kN \ \text{---- D.L.} \\ &= 86.25 \ kN \ \text{---- T.L.} \end{aligned}}$$

B_2

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.20}{6}\right) = 0.733$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.20}{6}\right)^2 = 0.905$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

$$= 3.0 + (0.733)(4.50)\left(\frac{3.2}{2}\right) + (4.50)\left(\frac{1.5}{2}\right) = 11.65 \ kN\backslash m'$$

$$p_a = C_a\, p_{si} \frac{L_s}{2} + p_{sh} \frac{L_s}{2} = (0.733)(1.25)\left(\frac{3.2}{2}\right) + (2.0)\left(\frac{1.5}{2}\right) = 2.96 \ kN\backslash m'$$

$$w_a = g_a + p_a = 11.65 + 2.96 = 14.61 \ kN\backslash m'$$

$$R_2 = g_a * Spacing = 11.65 * 6.0 = 69.9 \ kN \ \text{------} \ D.L.$$

$$= w_a * Spacing = 14.61 * 6.0 = 87.66 \ kN \ \text{------} \ T.L.$$

$$\boxed{\begin{aligned} R_2 &= 69.9 \ kN \ \text{-----} \ D.L. \\ &= 87.66 \ kN \ \text{-----} \ T.L. \end{aligned}}$$

Load For Moment.

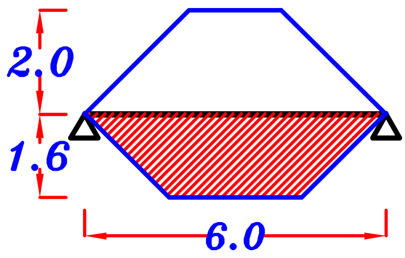
$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

$$= 3.0 + (0.905)(4.50)\left(\frac{3.2}{2}\right) + (4.50)\left(\frac{1.5}{2}\right) = 12.89 \ kN\backslash m'$$

$$p_e = C_e\, p_{si} \frac{L_s}{2} + p_{sh} \frac{L_s}{2} = (0.905)(1.25)\left(\frac{3.2}{2}\right) + (2.0)\left(\frac{1.5}{2}\right) = 3.31 \ kN\backslash m'$$

$$w_e = g_e + p_e = 12.89 + 3.31 = 16.20 \ kN\backslash m'$$

B_3



For Trapezoid 1 Inclined

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.20}{6}\right) = 0.733$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.20}{6}\right)^2 = 0.905$$

For Trapezoid 2 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$

Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2}$$

$$= 3.0 + (0.733)(4.50)\left(\frac{3.2}{2}\right) + (0.67)(4.50)\left(\frac{4.0}{2}\right) = 14.30 \text{ kN}\backslash m'$$

$$p_a = C_a\, p_{si} \frac{L_s}{2} + C_a\, p_{sh} \frac{L_s}{2} = (0.733)(1.25)\left(\frac{3.2}{2}\right) + (0.67)(2.0)\left(\frac{4.0}{2}\right) = 4.14 \text{ kN}\backslash m'$$

$$w_a = g_a + p_a = 14.30 + 4.14 = 18.44 \text{ kN}\backslash m'$$

$$R_3 = g_a * Spacing = 14.30 * 6.0 = 85.8 \text{ kN} \text{ ----- D.L.}$$

$$= w_a * Spacing = 18.44 * 6.0 = 110.64 \text{ kN} \text{ ----- T.L.}$$

$$\boxed{\begin{aligned} R_3 &= 85.8 \text{ kN --- D.L.} \\ &= 110.64 \text{ kN --- T.L.} \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + C_e\, g_s \frac{L_s}{2}$$

$$= 3.0 + (0.905)(4.50)\left(\frac{3.2}{2}\right) + (0.85)(4.50)\left(\frac{4.0}{2}\right) = 17.16 \text{ kN}\backslash m'$$

$$p_e = C_e\, p_{si} \frac{L_s}{2} + C_e\, p_{sh} \frac{L_s}{2} = (0.905)(1.25)\left(\frac{3.2}{2}\right) + (0.85)(2.0)\left(\frac{4.0}{2}\right) = 5.21 \text{ kN}\backslash m'$$

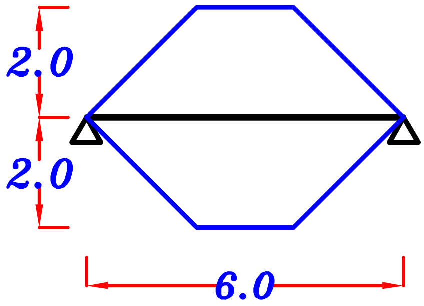
$$w_e = g_e + p_e = 17.16 + 5.21 = 22.37 \text{ kN}\backslash m'$$

B_4

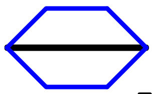
For Trapezoid 2 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



Load For Shear.



$$g_a = O.W. + 2\, C_a\, g_s\, \frac{L_s}{2} = 3.0 + 2\,(0.67)\,(4.50)\left(\frac{4.0}{2}\right) = 15.06 \text{ kN/m}'$$

$$p_a = 2\, C_a\, p_{sh}\, \frac{L_s}{2} = 2\,(0.67)\,(2.0)\left(\frac{4.0}{2}\right) = 5.36 \text{ kN/m}'$$

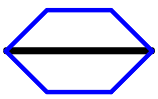
$$w_a = g_a + p_a = 15.06 + 5.36 = 20.42 \text{ kN/m}'$$

$$R_4 = g_a * \text{Spacing} = 15.06 * 6.0 = 90.36 \text{ kN} \text{ ----- D.L.}$$

$$= w_a * \text{Spacing} = 20.42 * 6.0 = 122.52 \text{ kN} \text{ ----- T.L.}$$

$$\boxed{\begin{aligned} R_4 &= 90.36 \text{ kN --- D.L.} \\ &= 122.52 \text{ kN --- T.L.} \end{aligned}}$$

Load For Moment.



$$g_e = O.W. + 2\, C_e\, g_s\, \frac{L_s}{2} = 3.0 + 2\,(0.85)\,(4.50)\left(\frac{4.0}{2}\right) = 18.30 \text{ kN/m}'$$

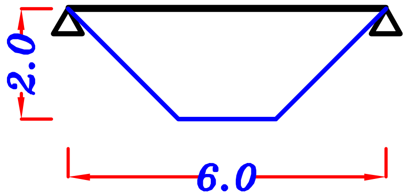
$$p_e = 2\, C_e\, p_{sh}\, \frac{L_s}{2} = 2\,(0.85)\,(2.0)\left(\frac{4.0}{2}\right) = 6.80 \text{ kN/m}'$$

$$w_e = g_e + p_e = 18.30 + 6.80 = 25.10 \text{ kN/m}'$$

B_5 For Trapezoid 2 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s\, \frac{L_s}{2} = 3.0 + (0.67)(4.50)\left(\frac{4.0}{2}\right) = 9.03 \text{ kN}\backslash m'$$

$$p_a = C_a\, p_{sh}\, \frac{L_s}{2} = (0.67)(2.0)\left(\frac{4.0}{2}\right) = 2.68 \text{ kN}\backslash m'$$

$$w_a = g_a + p_a = 9.03 + 2.68 = 11.71 \text{ kN}\backslash m'$$

$$R_5 = g_a * \text{Spacing} = 9.03 * 6.0 = 54.18 \text{ kN} \text{ ---- D.L.}$$

$$= w_a * \text{Spacing} = 11.71 * 6.0 = 70.26 \text{ kN} \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_5 &= 54.18 \text{ kN --- D.L.} \\ &= 70.26 \text{ kN ---- T.L.} \end{aligned}}$$

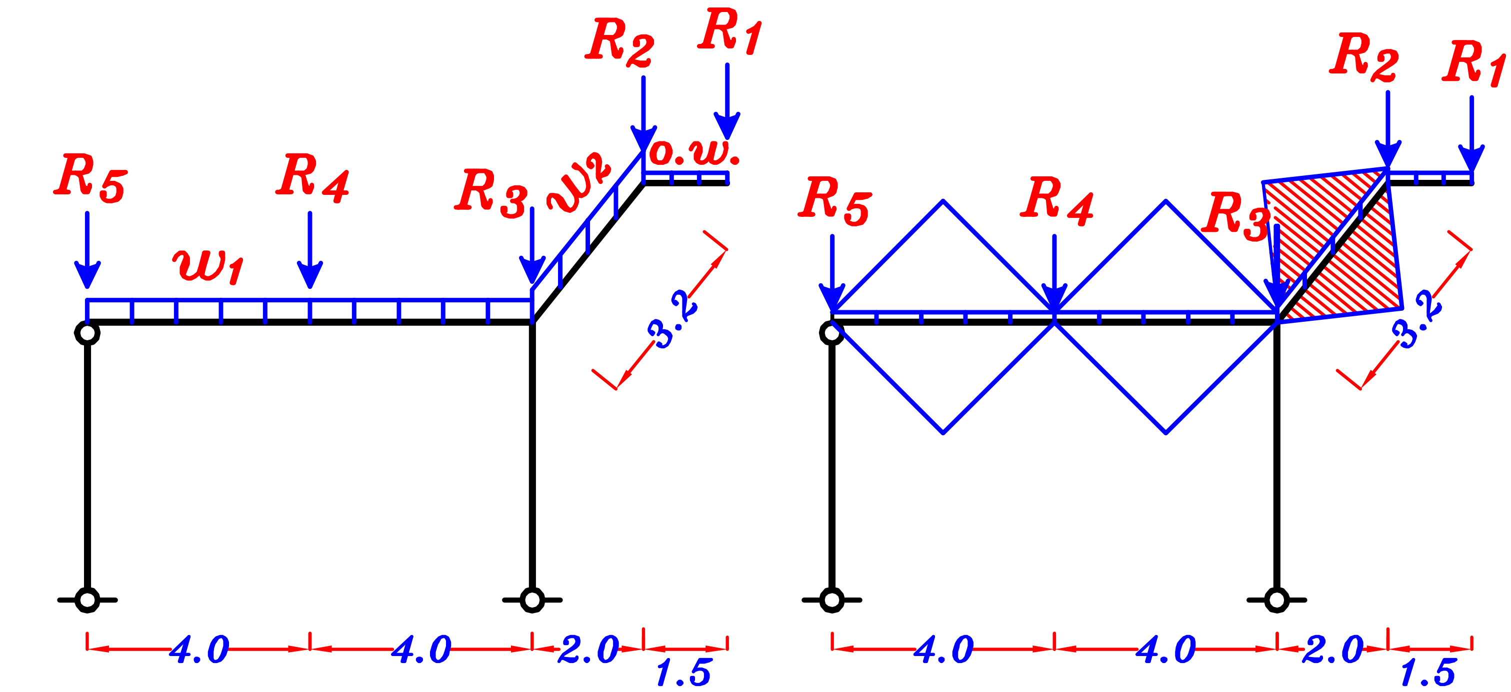
Load For Moment.

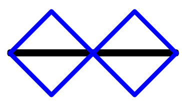
$$g_e = O.W. + C_e\, g_s\, \frac{L_s}{2} = 3.0 + (0.85)(4.50)\left(\frac{4.0}{2}\right) = 10.65 \text{ kN}\backslash m'$$

$$p_e = C_e\, p_{sh}\, \frac{L_s}{2} = (0.85)(2.0)\left(\frac{4.0}{2}\right) = 3.40 \text{ kN}\backslash m'$$

$$w_e = g_e + p_e = 10.65 + 3.40 = 14.05 \text{ kN}\backslash m'$$

3- Draw the N.F.D. (total load), S.F.D. (total load) and max-max B.M.D. For an intermediate Frame (F), using ultimate limit loads.





w_1

$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}(4.0)(2.0)\right)}{8.0} = 2.0$$

$$g_{1a} = g_{1e} = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (2.0)(4.50) = 15.0 \ kN\backslash m'$$

$$p_{1a} = p_{1e} = \frac{\sum area}{span} * p_{sh} = (2.0)(2.0) = 4.0 \ kN\backslash m'$$

$$w_{1a} = w_{1e} = g_a + p_a = 15.0 + 4.0 = 19.0 \ kN\backslash m'$$

w_2

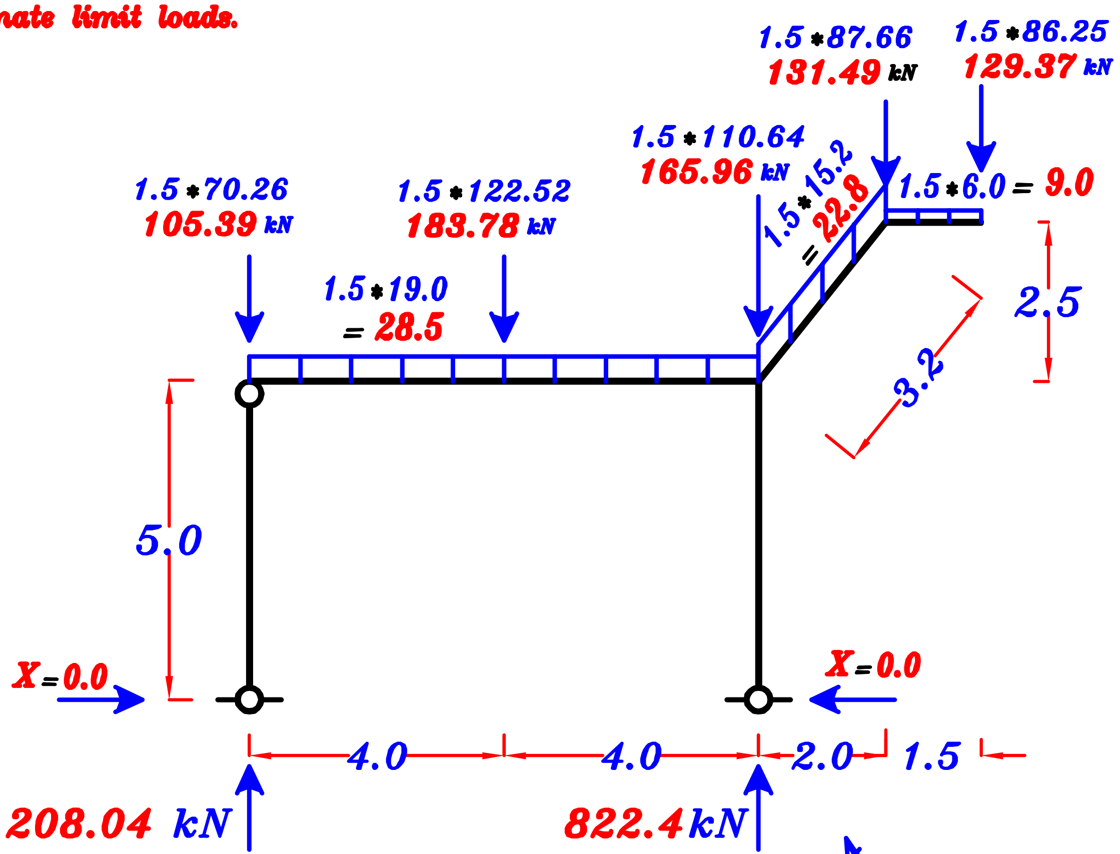
$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3.2)(1.6)\right)}{3.2} = 1.60$$

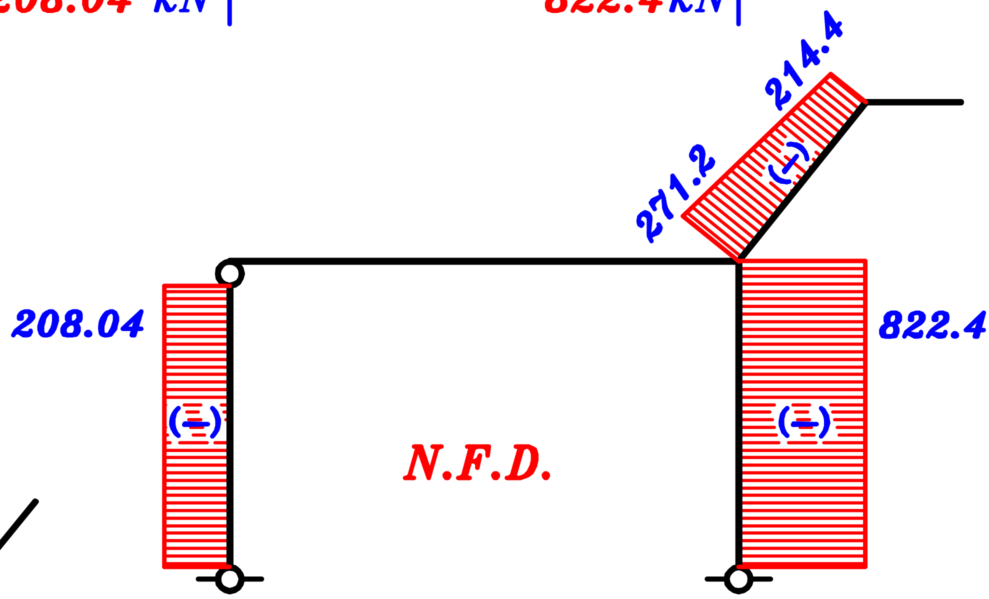
$$g_{2a} = g_{2e} = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.60)(4.50) = 13.2 \ kN\backslash m'$$

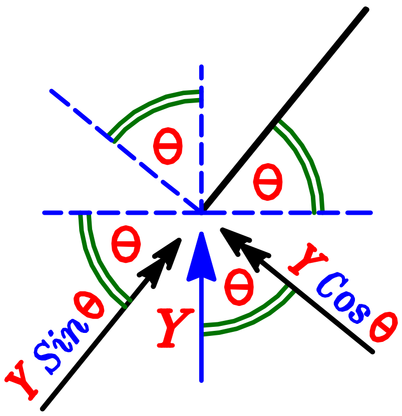
$$p_{2a} = p_{2e} = \frac{\sum area}{span} * p_{si} = (1.60)(1.25) = 2.0 \ kN\backslash m'$$

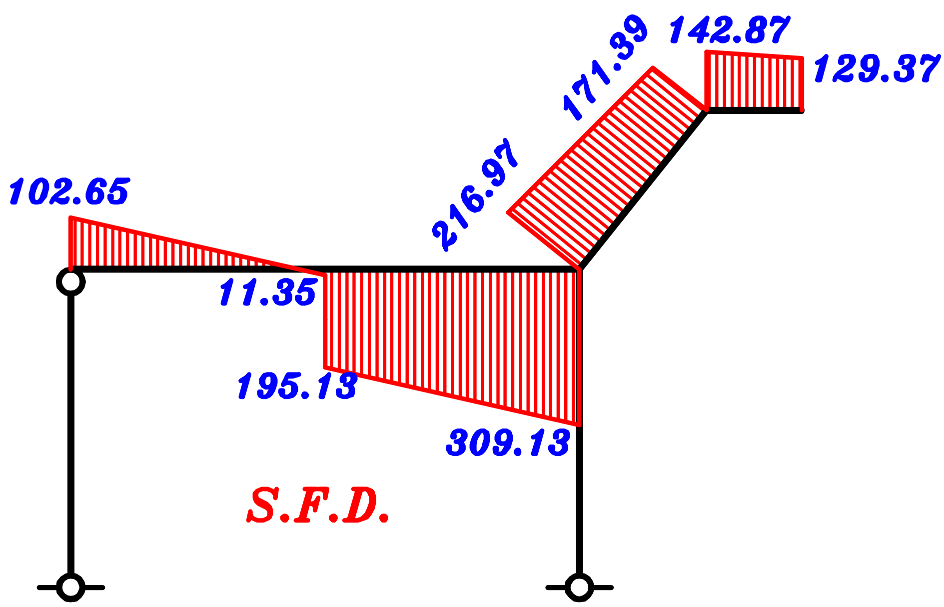
$$w_{2a} = w_{2e} = g_a + p_a = 13.2 + 2.0 = 15.2 \ kN\backslash m'$$

3- Draw the N.F.D. (total load), S.F.D. (total load) For an intermediate Frame (F) using ultimate limit loads.

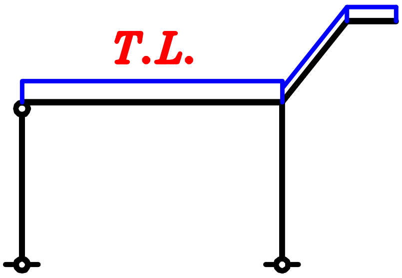




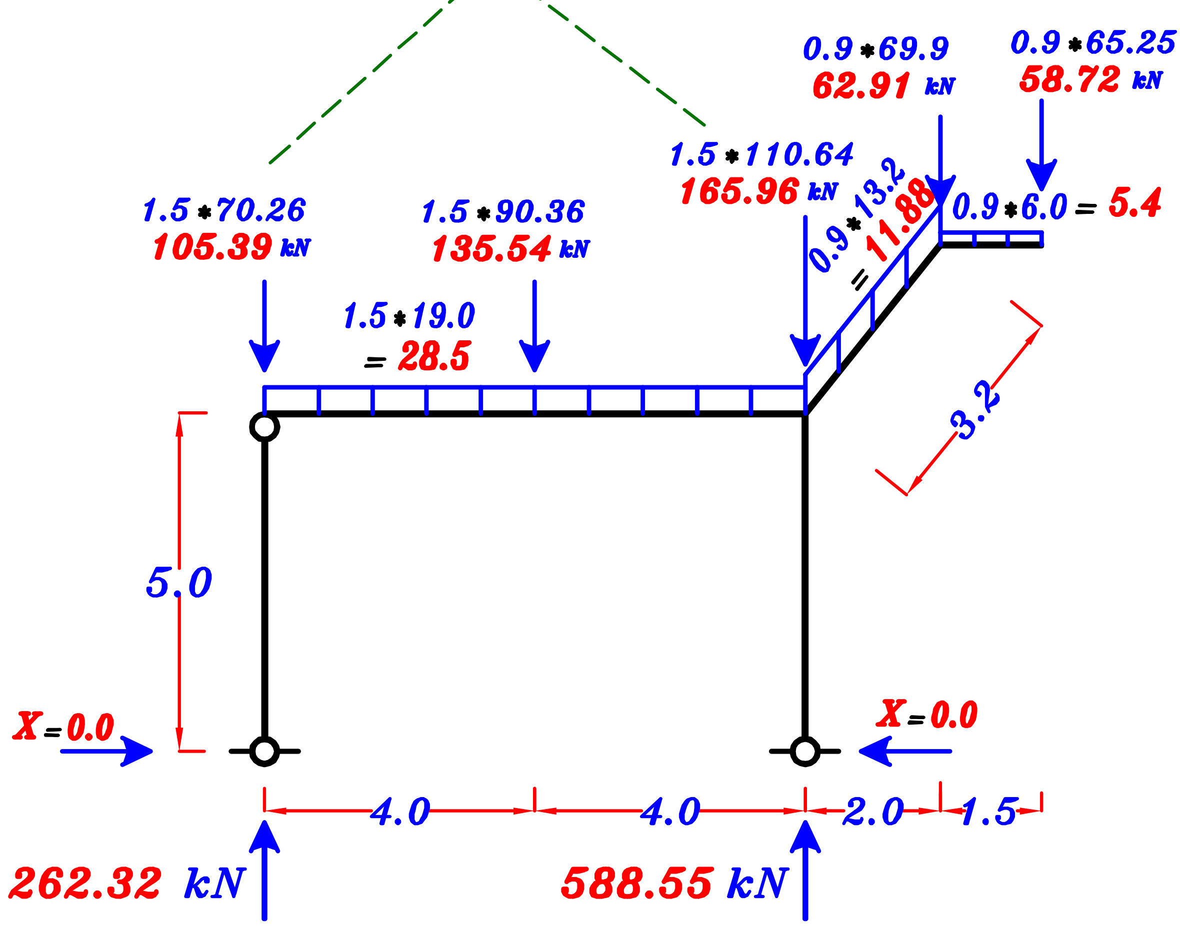


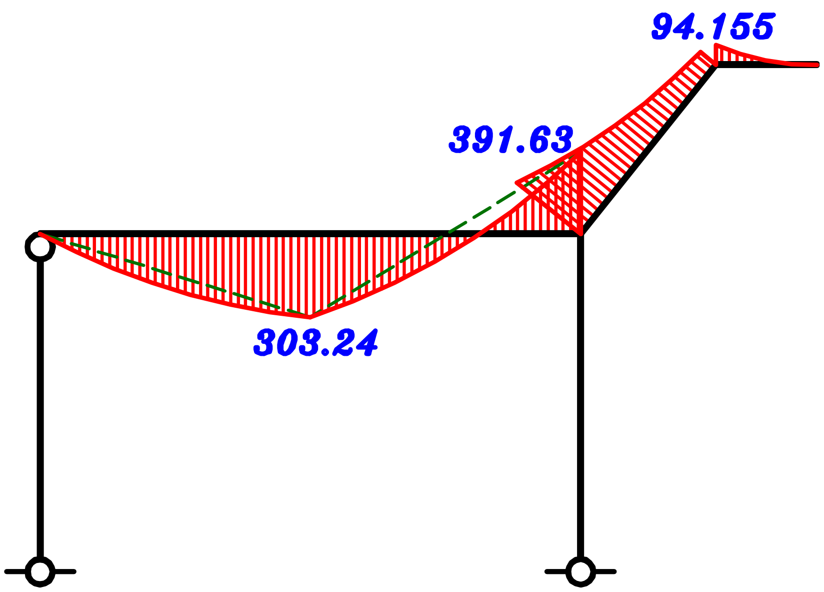


3- Draw the max-max B.M.D. For an intermediate Frame (F) using ultimate limit loads.



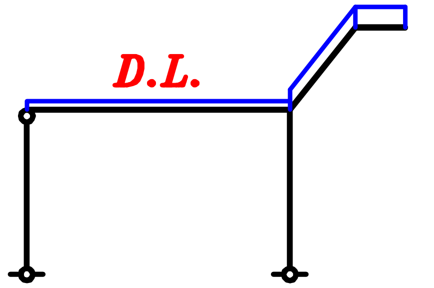
في جميع حالات التحميل نأخذ الحمل
فوق العمود T.L. لانه لن يؤثر على عزم الـ Frame
و لكنه سيزيد من الـ Normal على العمود





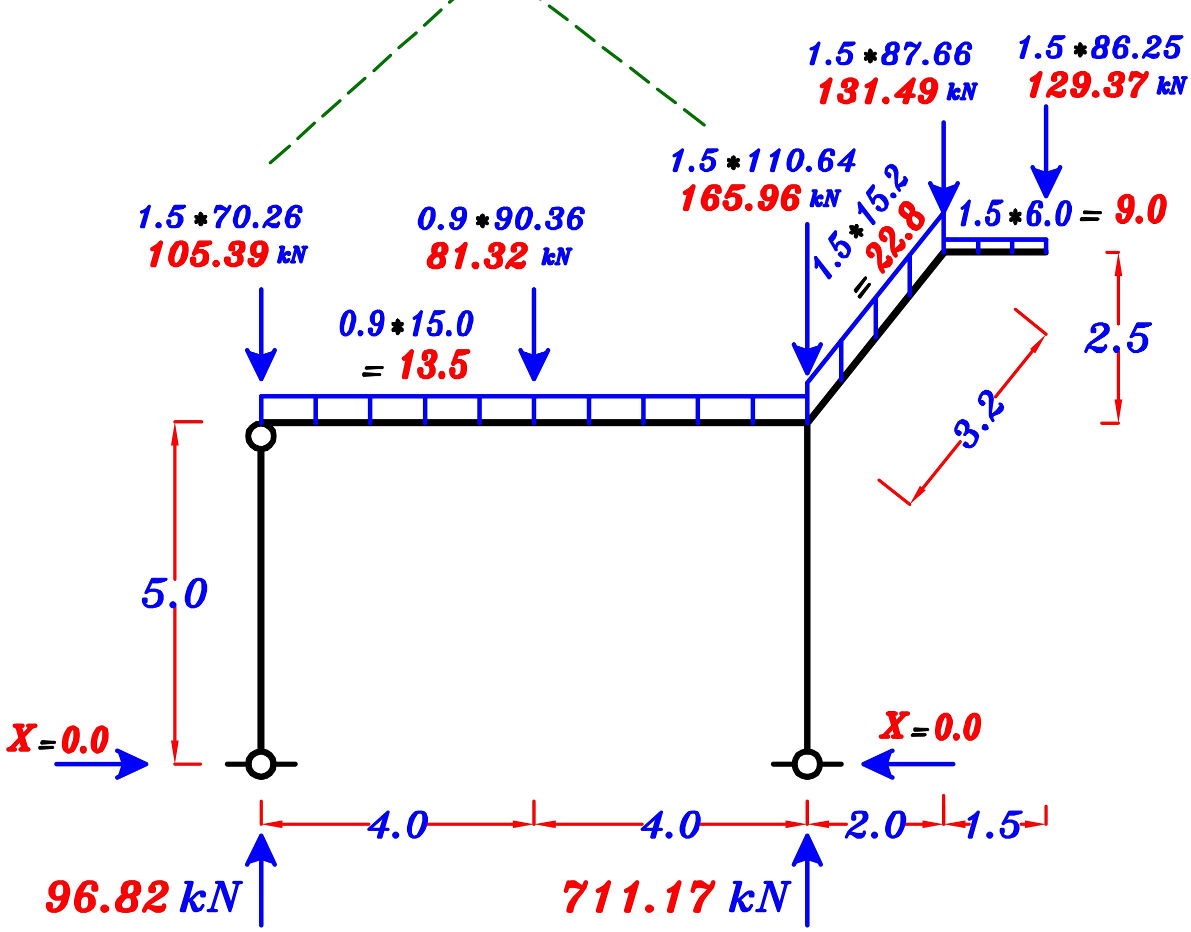
max (+Ve) B.M.D.

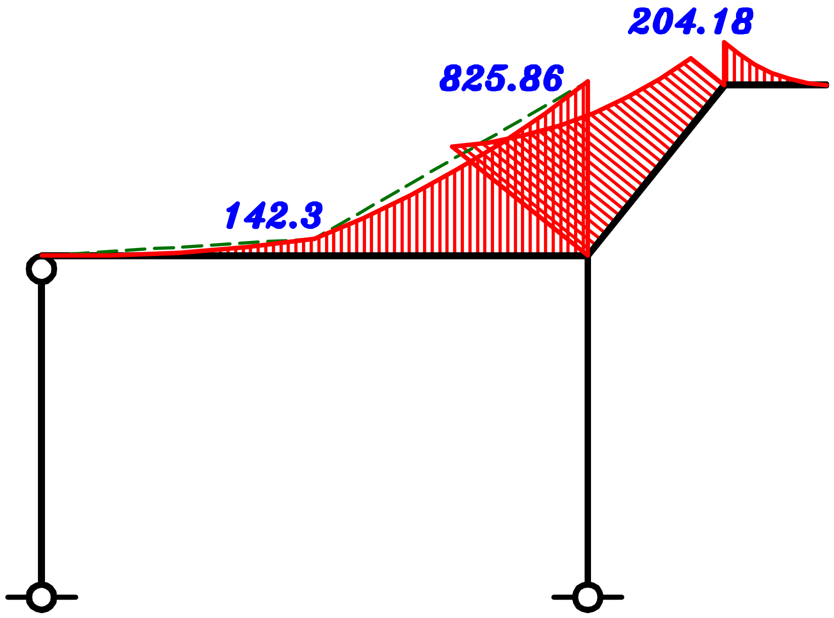
3- Draw the max–max B.M.D. For an intermediate Frame (F) using ultimate limit loads.



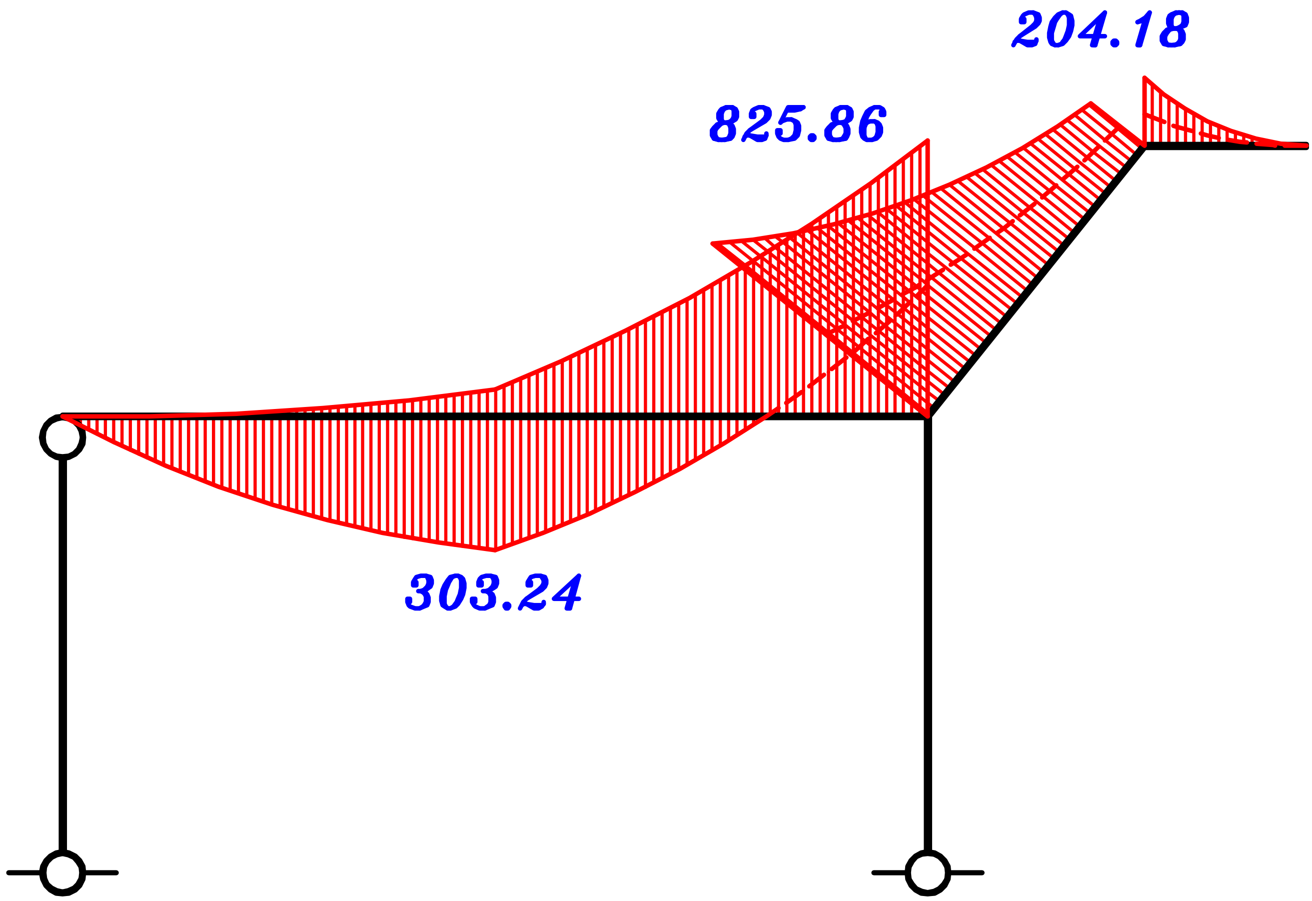
max (–Ve) B.M.D.

فى جميع حالات التحميل نأخذ الحمل
فوق العمود T.L. لانه لن يؤثر على عزم ال Frame
و لكنه سيزيد من ال Normal على العمود





max (–Ve) B.M.D.



max–max **B.M.D.**

Example.

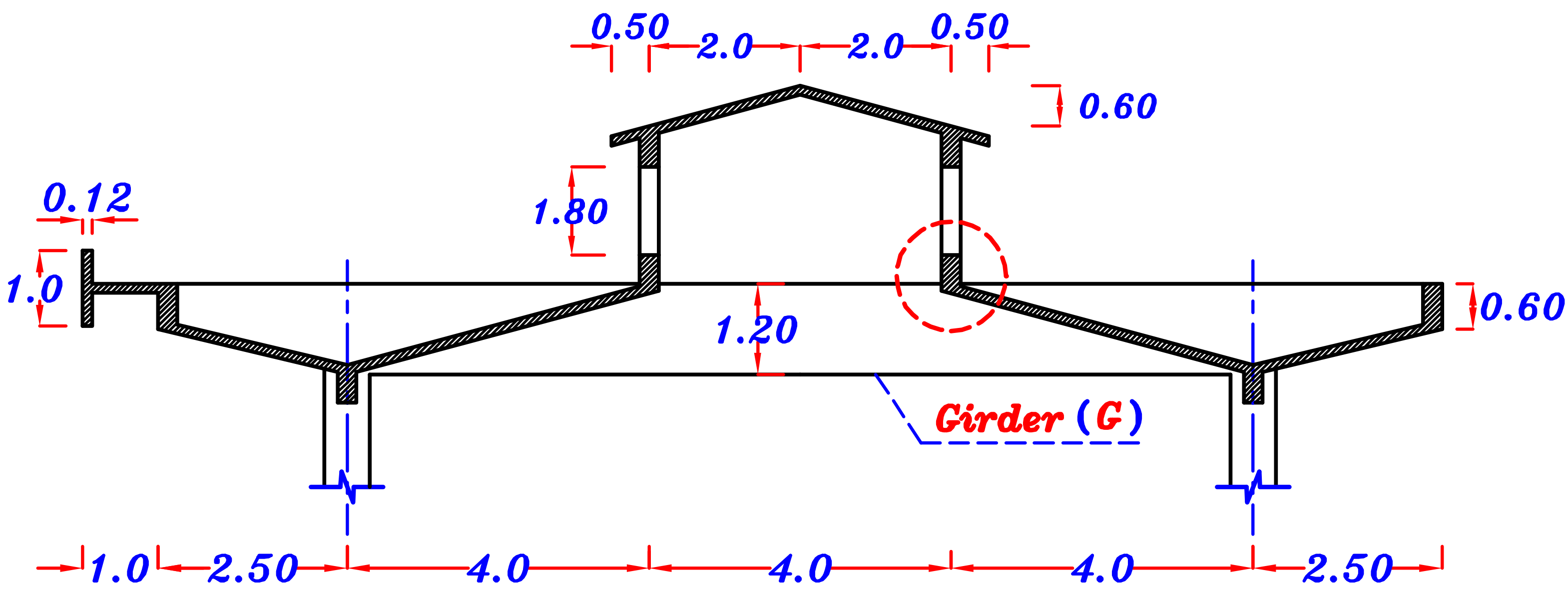


Figure 1

Figure 1 shows a sectional elevation of a reinforced concrete roof. The roof is covered by reinforced concrete slabs supported by a system of secondary beams. and Girders (G), spaced at 6.0 m .

It is required:

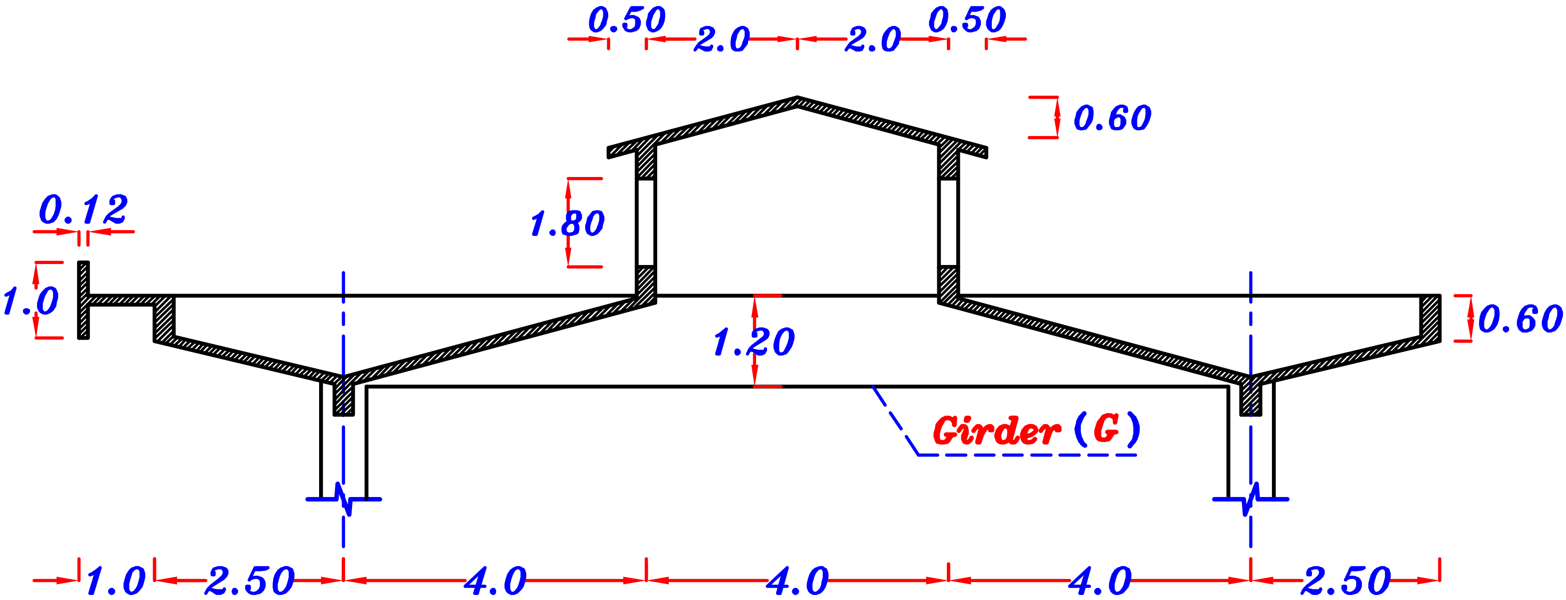
1 - Draw a structural plan showing the pattern of load distribution.

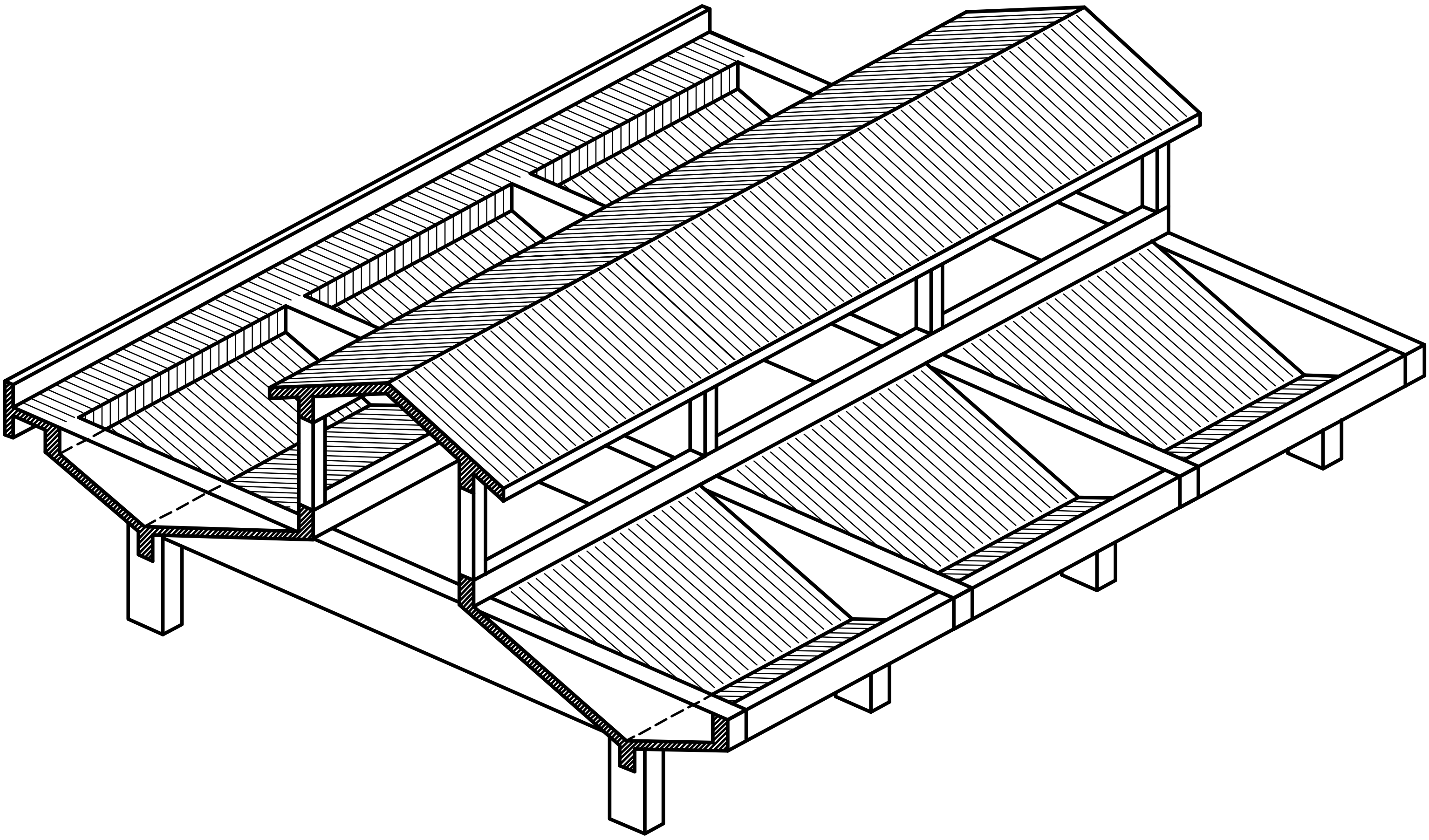
2 - Calculate the equivalent working loads for shear and moment For an intermediate Girder (G).

3 - Draw the S.F.D. (**total loads**) and max.-max. B.M.D. For an intermediate Girder (G). **using ultimate limit loads.**

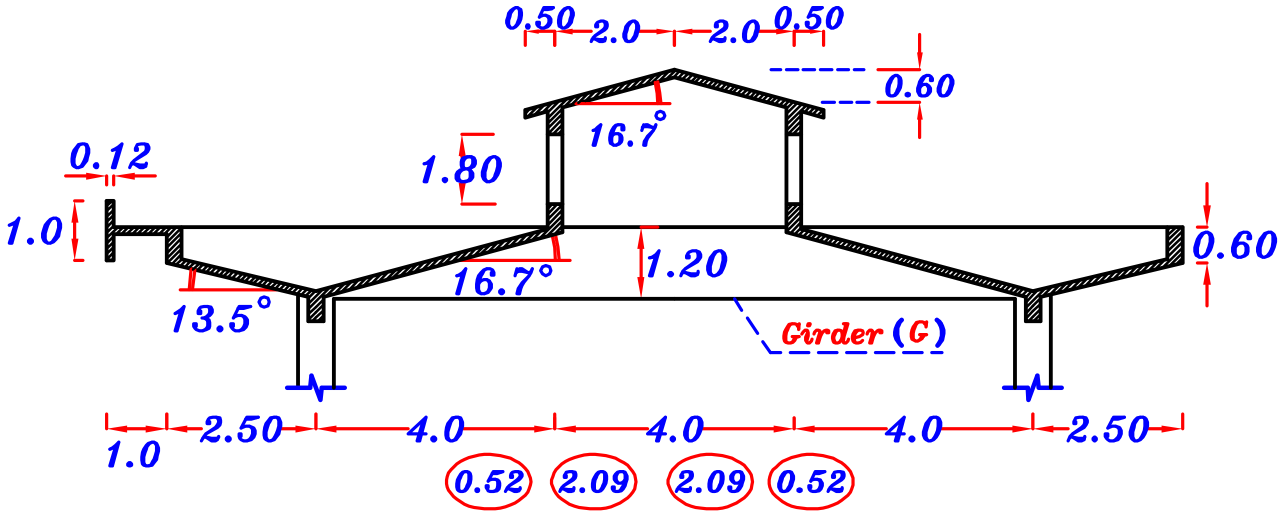
Data:

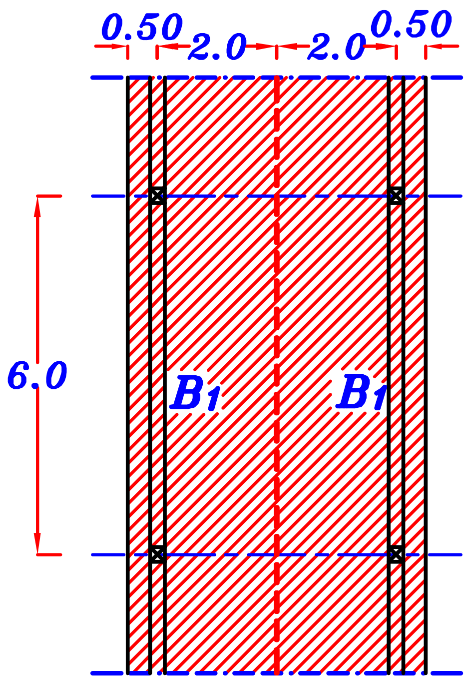
- Slab thickness $t_s = 120$ mm
- Live load = 1.0 $kN\backslash m^2$
- Floor cover = 1.5 $kN\backslash m^2$
- Breadth of all beams = 250 mm
- Breadth of all girders = 300 mm
- Own weight of beams = 3.0 $kN\backslash m$
- Own weight of girders = 6.0 $kN\backslash m$

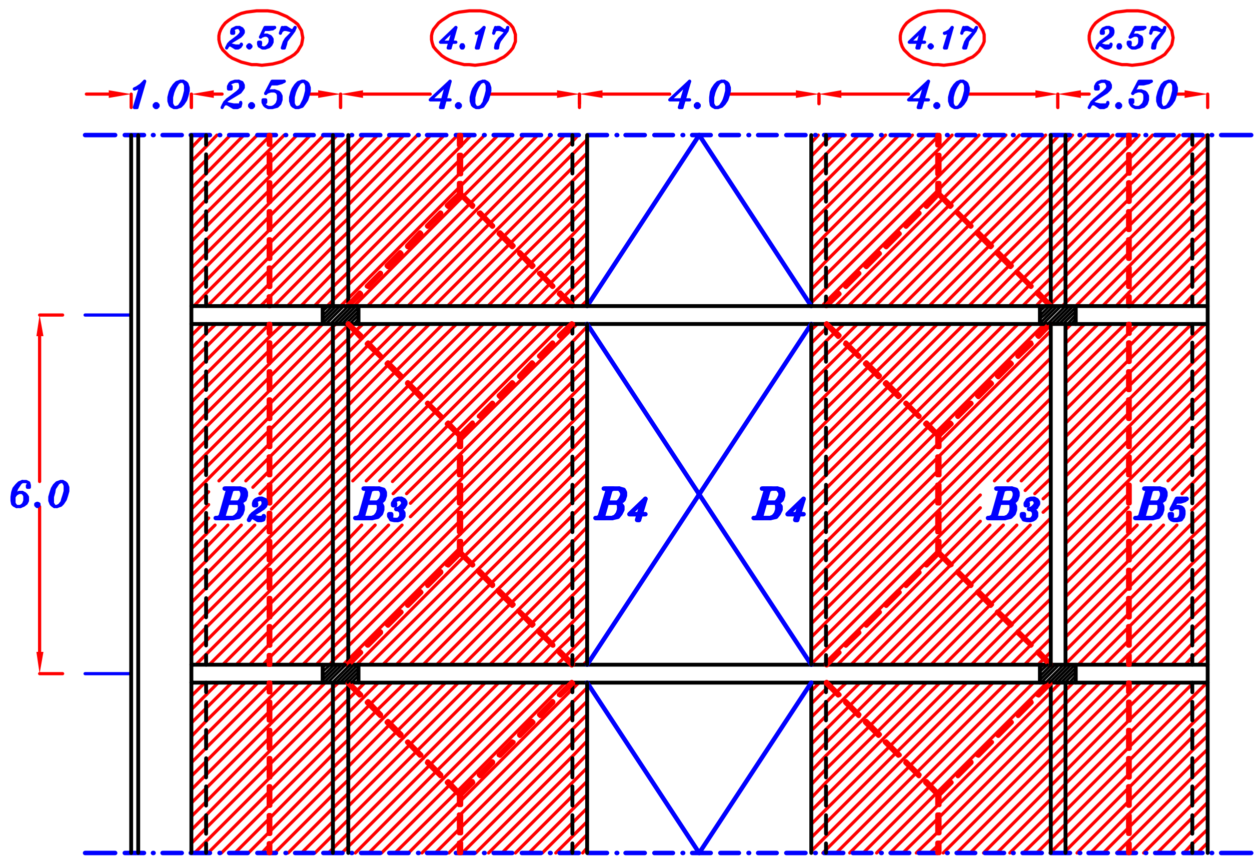




ملحوظه هامه . البلاطه مائله لكن ال Girder أفقى


0.50
2.0
2.0
0.50
0.60
16.7°
1.80
0.12
1.0
1.20
0.60
16.7°
13.5°
Girder (G)
1.0
2.50
4.0
4.0
4.0
2.50
0.52
2.09
2.09
0.52


0.50
2.0
2.0
0.50
6.0
B1
B1


2.57
4.17
4.17
2.57
1.0
2.50
4.0
4.0
4.0
2.50
6.0
B2
B3
B4
B4
B3
B5

g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 1.0 \ kN\backslash m^2 \quad \text{------ HL. Slab.}$$

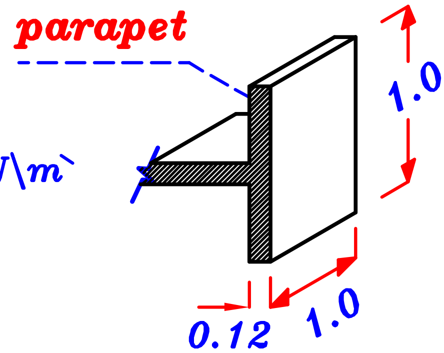
$$p_{si1} = L.L. * \cos\theta = 1.0 * \cos 16.7^\circ = 0.957 \ kN\backslash m^2 \quad \text{--- For Inclination } 16.7^\circ$$

$$p_{si2} = L.L. * \cos\theta = 1.0 * \cos 13.5^\circ = 0.972 \ kN\backslash m^2 \quad \text{--- For Inclination } 13.5^\circ$$

$$\boxed{g_s = 4.50 \ kN\backslash m^2} \ , \ \boxed{p_{sh} = 1.0 \ kN\backslash m^2}$$

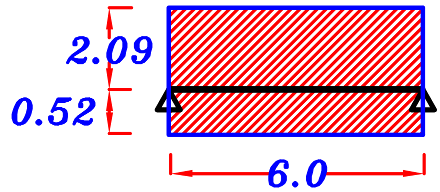
$$\boxed{p_{si1} = 0.957 \ kN\backslash m^2} \ , \ \boxed{p_{si2} = 0.972 \ kN\backslash m^2}$$

O.W. of parapet



$$\text{O.W. of parapet} = (0.12)(1.0)(1.0)(25) = 3.0 \ kN\backslash m'$$

B_1 Load For Shear.



$$g_a = o.w. + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.0 + (4.50)(2.09) + (4.50)(0.52) = 14.74 \ kN\backslash m'$$

$$p_a = p_{si1} \frac{L_s}{2} + p_{si1} L_c$$

$$= (0.957)(2.09) + (0.957)(0.52) = 2.49 \ kN\backslash m'$$

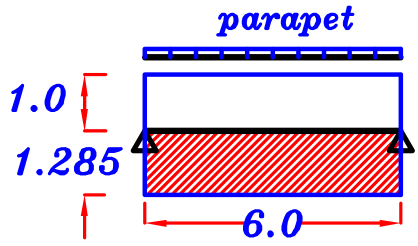
$$w_a = g_a + p_a = 14.74 + 2.49 = 17.23 \ kN\backslash m'$$

$$R_1 = g_a * Spacing = 14.74 * 6.0 = 88.44 \ kN \quad \text{------ D.L.}$$

$$= w_a * Spacing = 17.23 * 6.0 = 103.38 \ kN \quad \text{------ T.L.}$$

$$\boxed{\begin{aligned} R_1 &= 88.44 \ kN \quad \text{------ D.L.} \\ &= 103.38 \ kN \quad \text{------ T.L.} \end{aligned}}$$

B_2 Load For Shear.



$$g_a = o.w. + g_s \frac{L_s}{2} + g_s L_c + parapet$$

$$= 3.0 + (4.50)\left(\frac{2.57}{2}\right) + (4.50)(1.0) + 3.0 = 16.28 \ kN\backslash m'$$

$$p_a = p_{si2} \frac{L_s}{2} + p_{sh} L_c$$

$$= (0.972)\left(\frac{2.57}{2}\right) + (1.0)(1.0) = 2.25 \ kN\backslash m'$$

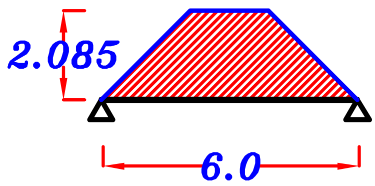
$$w_a = g_a + p_a = 16.28 + 2.25 = 18.53 \ kN\backslash m'$$

$$R_2 = g_a * Spacing = 16.28 * 6.0 = 97.68 \ kN \text{ ------ D.L.}$$

$$= w_a * Spacing = 18.53 * 6.0 = 111.18 \ kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 97.68 \ kN \text{ ------ D.L.} \\ &= 111.18 \ kN \text{ ------ T.L.} \end{aligned}}$$

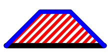
B_4 For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.17}{6}\right) = 0.652$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.17}{6}\right)^2 = 0.839$$

Load For Shear.



$$g_a = o.w. + C_a g_s \frac{L_s}{2} = 3.0 + (0.652)(4.50)\left(\frac{4.17}{2}\right) = 9.12 \ kN\backslash m'$$

$$p_a = C_a p_{si1} \frac{L_s}{2} = (0.652)(0.957)\left(\frac{4.17}{2}\right) = 1.30 \ kN\backslash m'$$

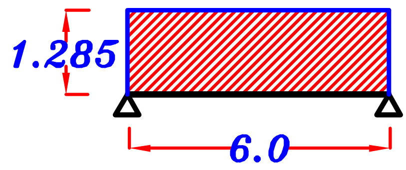
$$w_a = g_a + p_a = 9.12 + 1.30 = 10.42 \ kN\backslash m'$$

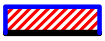
$$R_4 = g_a * Spacing = 9.12 * 6.0 = 54.72 \ kN \text{ ------ D.L.}$$

$$= w_a * Spacing = 10.42 * 6.0 = 62.52 \ kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_4 &= 54.72 \ kN \text{ ------ D.L.} \\ &= 62.52 \ kN \text{ ------ T.L.} \end{aligned}}$$

B_5 Load For Shear.





$$g_a = o.w. + g_s \frac{L_s}{2} = 3.0 + (4.50)\left(\frac{2.57}{2}\right) = 8.78 \quad kN\backslash m`$$

$$p_a = p_{si2} \frac{L_s}{2} = (0.972)\left(\frac{2.57}{2}\right) = 1.25 \quad kN\backslash m`$$

$$w_a = g_a + p_a = 8.78 + 1.25 = 10.03 \quad kN\backslash m`$$

$$R_5 = g_a * Spacing = 8.78 * 6.0 = 52.68 \quad kN \text{ ------ } D.L.$$

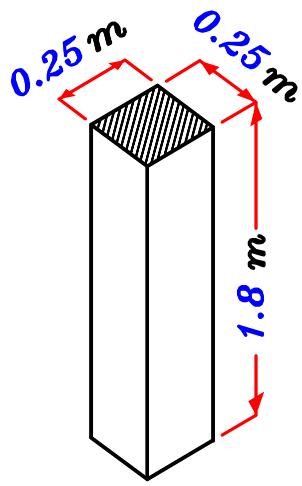
$$= w_a * Spacing = 10.03 * 6.0 = 60.18 \quad kN \text{ ------ } T.L.$$

$$\boxed{\begin{aligned} R_5 &= 52.68 \; kN \text{ ------ } D.L. \\ &= 60.18 \; kN \text{ ------ } T.L. \end{aligned}}$$

Post

Weight of the Post = Volume * Density

$$= (0.25 * 0.25 * 1.80)(25) = 2.81 \quad kN$$

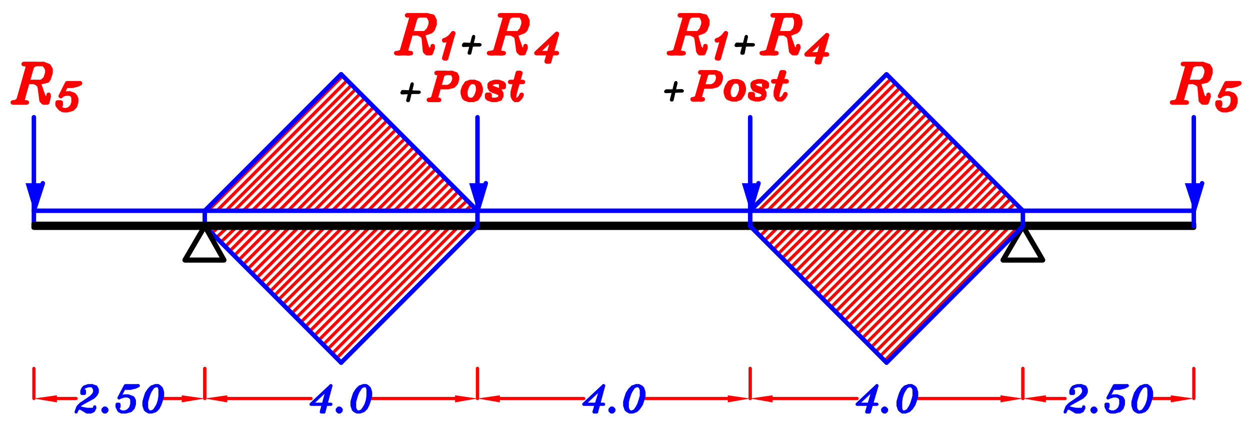


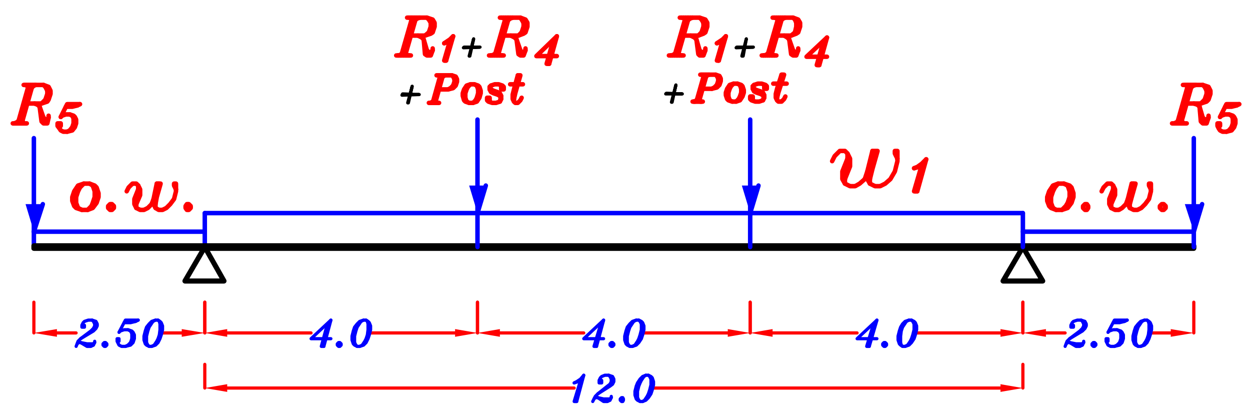
$$\boxed{\text{Weight of the Post} = 2.81 \; kN}$$

Note : Weight of Post can be neglected.

Loads on the Girder.

ملحوظه هامه . البلاطه مائله لكن ال Girder أفقى





$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}(4.17)\left(\frac{4.17}{2}\right)\right)}{12.0} = 1.45$$

$$g_1 = g_a = g_e = o.w. + \frac{\sum area}{span} * g_s$$

$$= 6.0 + 1.45\ (4.50) = 12.52\ kN\backslash m$$

$$p_1 = p_a = p_e = \frac{\sum area}{span} * p_{si1}$$

$$= 1.45\ (0.957) = 1.387\ kN\backslash m`$$

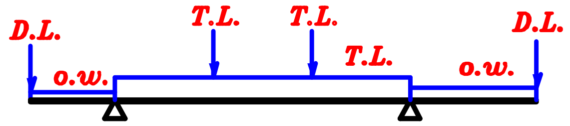
$$w_1 = w_a = w_e = g_1 + p_1 = 12.52 + 1.387 = 13.91\ kN\backslash m`$$

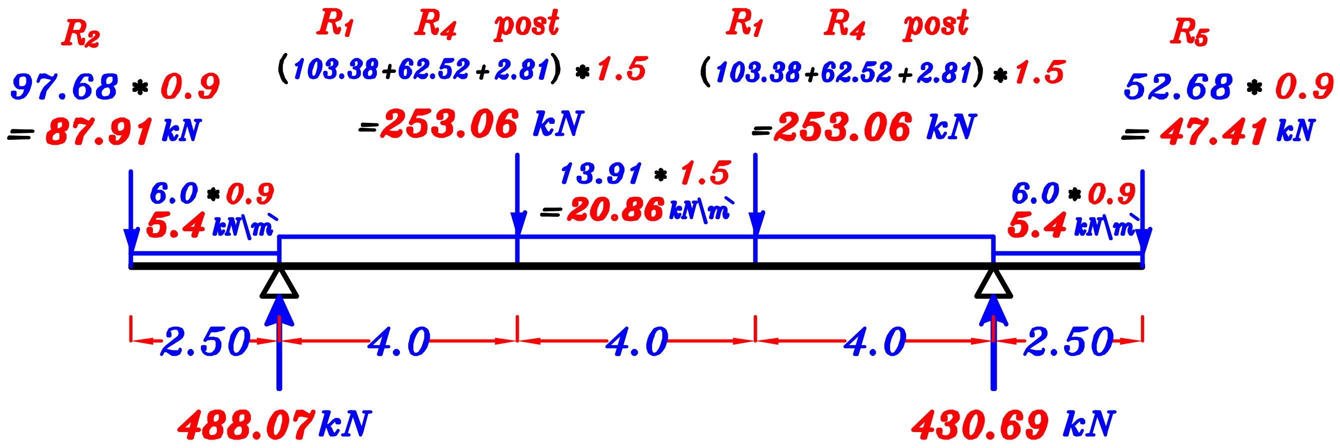
$$g_1 = 12.52\ kN\backslash m` \text{ ---- D.L.}$$

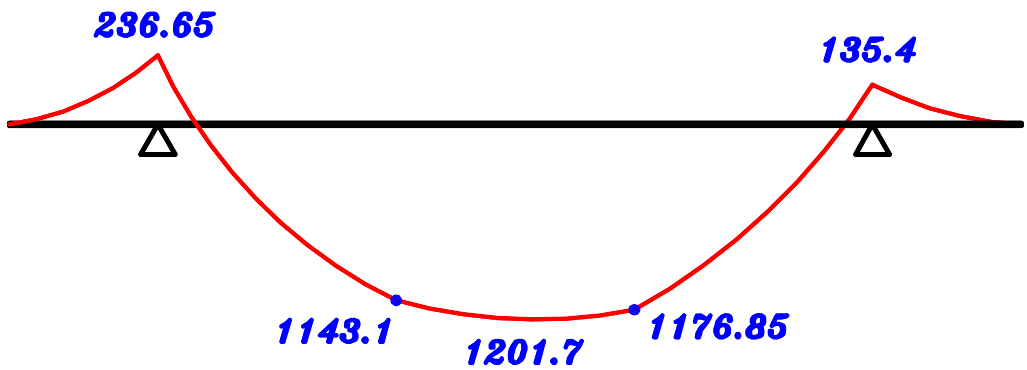
$$w_1 = 13.91\ kN\backslash m` \text{ ---- T.L.}$$

max-max U.L. B.M.D. For the Girder.

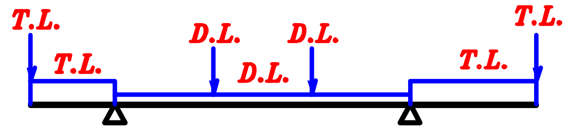
1- max. +ve B.M.D.

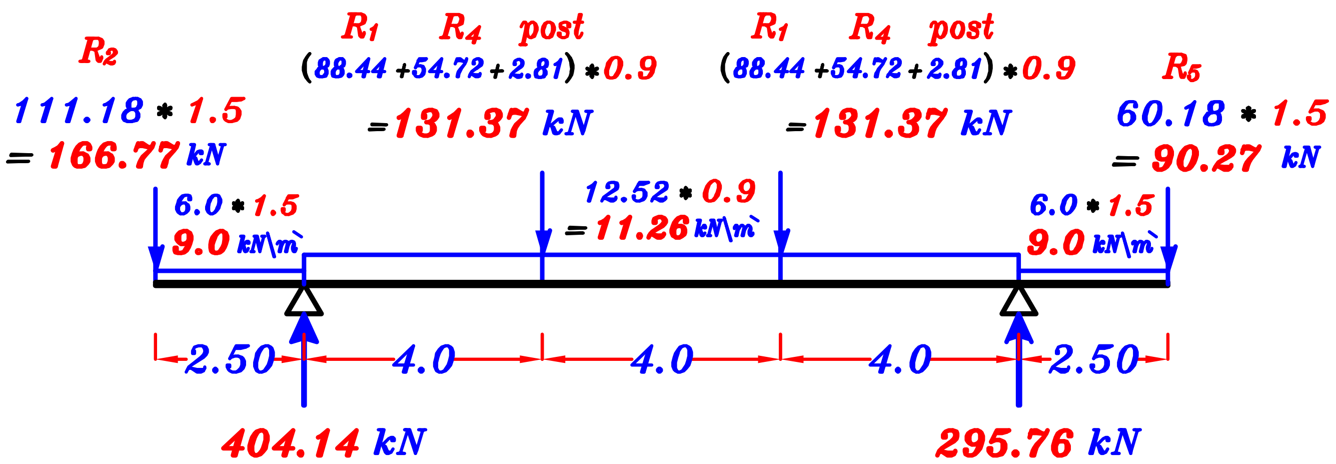


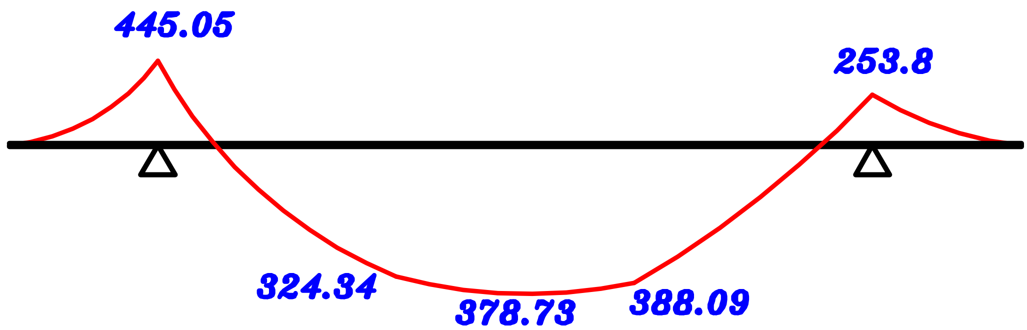




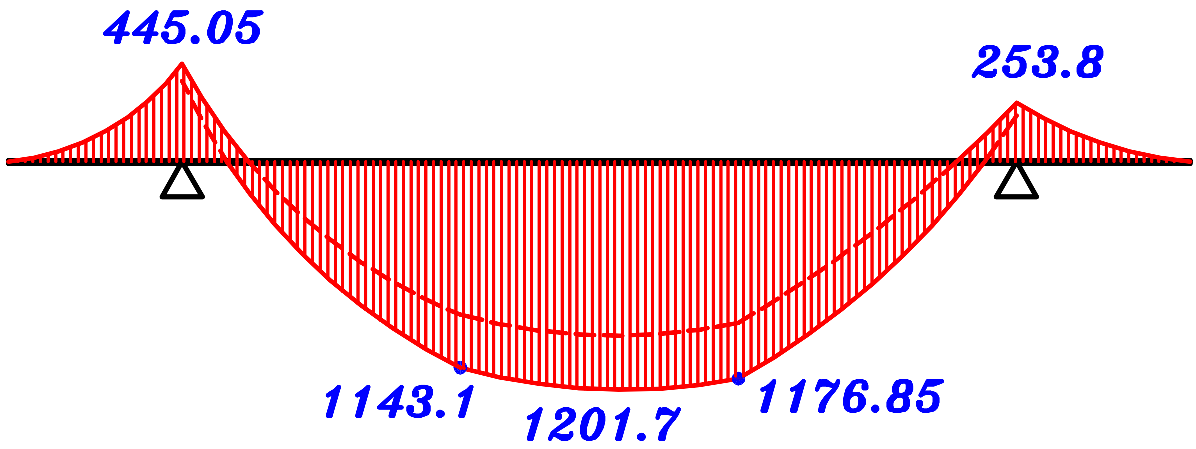
2- max. -ve B.M.D.



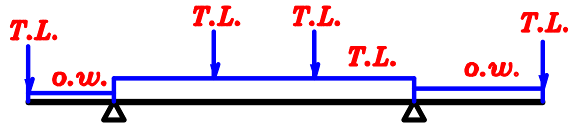


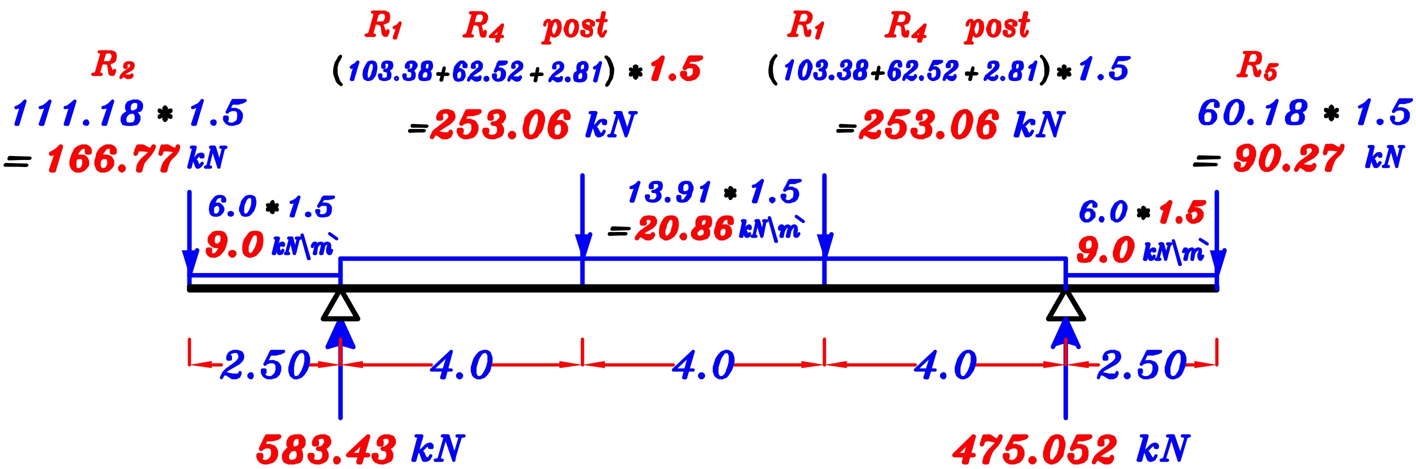


max–max B.M.D. For the Girder.

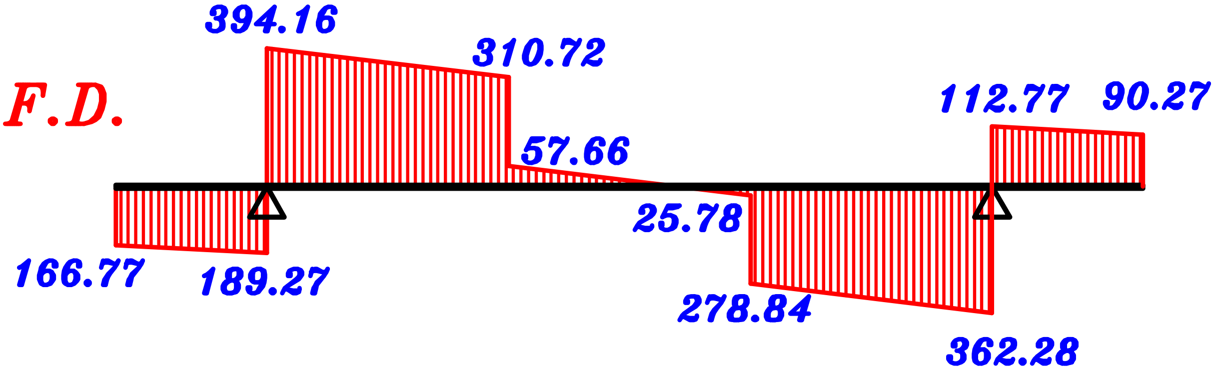


S.F.D. For the Girder.

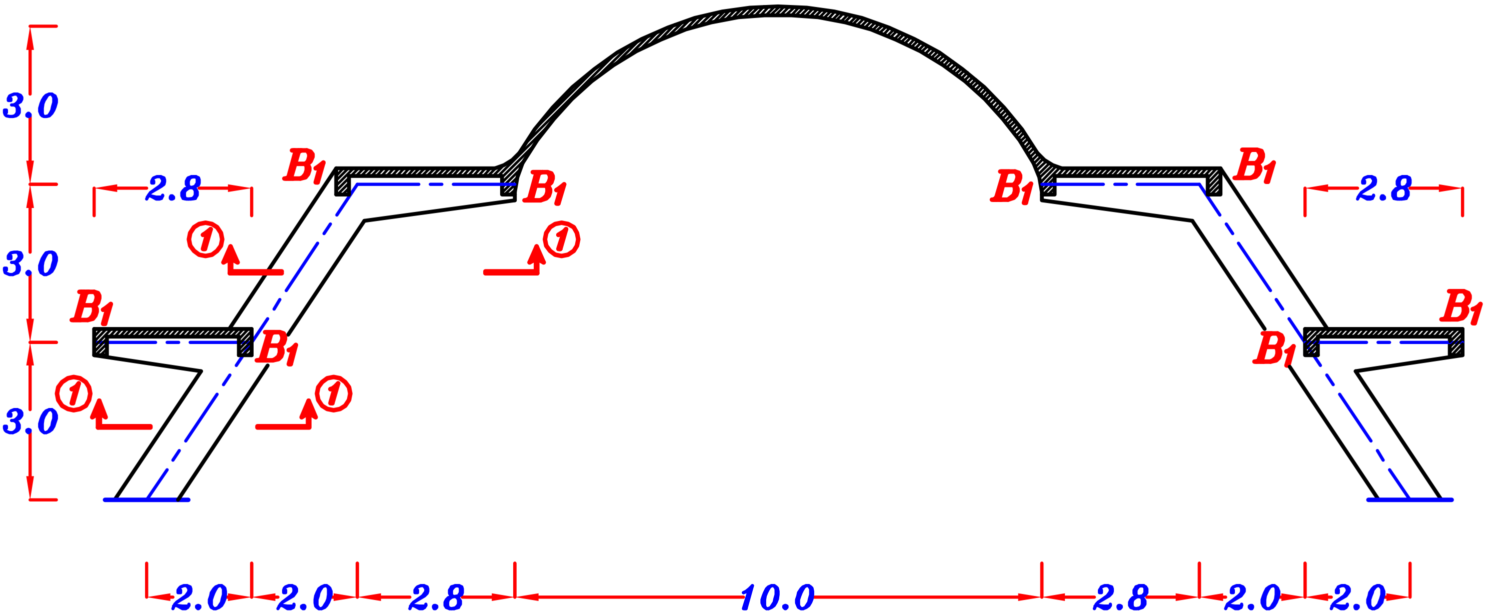


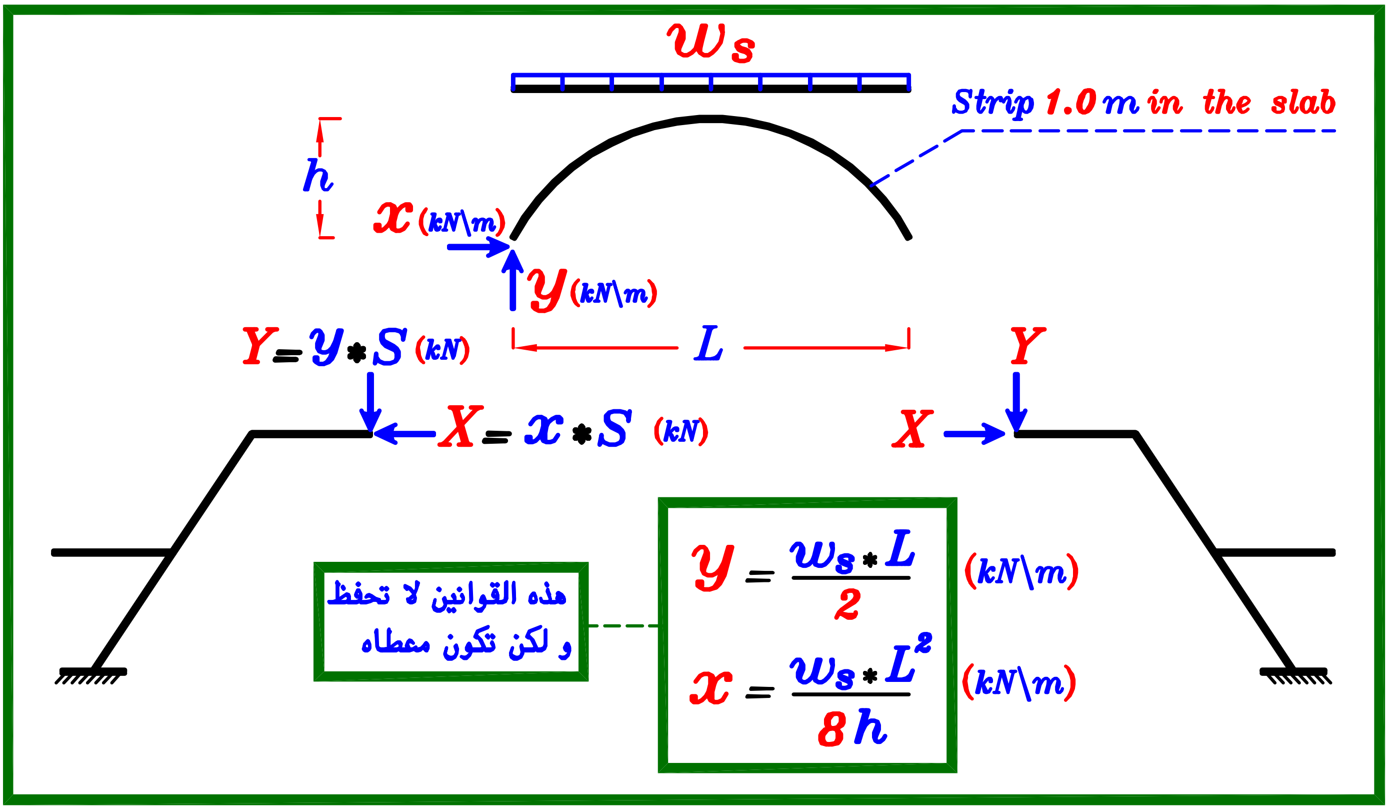


S.F.D.



Example.





Data.

$t_s = 0.12\ m$, $F.C. = 1.50\ N\backslash mm^2$, $L.L. = 2.0\ N\backslash mm^2$

$Spacing = 6.0\ m$, $o.w._{(Frame)} = 6.0\ kN\backslash m'$, $o.w._{(Beams)} = 3.0\ kN\backslash m'$

Req.

Draw Internal Forces Diagrams For the Frame.

(Case of total Load only)

$$w_s = t_s * \gamma_c + F.C. + L.L.$$

$$= 0.12 * 25 + 1.50 + 2.0 = 6.50 \ kN\backslash m^2$$

$$\boxed{w_s = 6.50 \ kN\backslash m^2}$$

$L = 10 \ m$, $h = 3.0 \ m$

هذه القوانين لا تحفظ
و لكن تكون معطاه

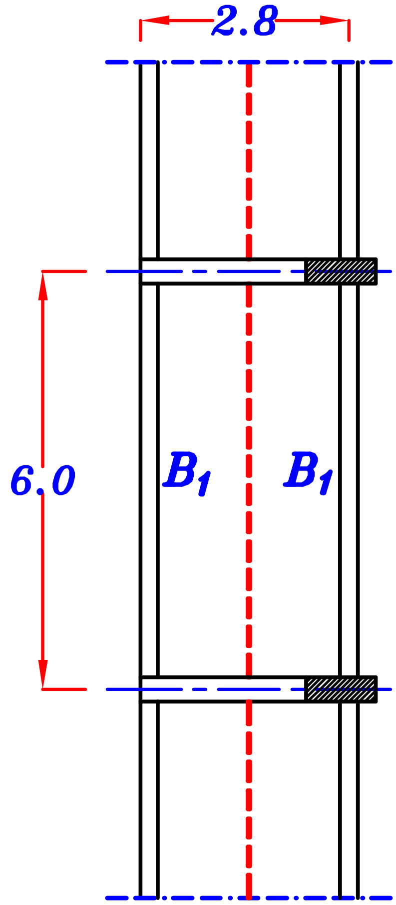
$$y = \frac{w_s * L}{2} = \frac{6.50 * 10}{2} = 32.5 \ kN\backslash m$$

$$Y = y * S = 32.5 * 6.0 = 195 \ kN \qquad \boxed{Y = 195 \ kN}$$

$$x = \frac{w_s * L^2}{8h} = \frac{6.50 * 10^2}{8 * 3.0} = 27.08 \ kN\backslash m$$

$$X = x * S = 27.08 * 6.0 = 162.5 \ kN \qquad \boxed{X = 162.5 \ kN}$$

B_1



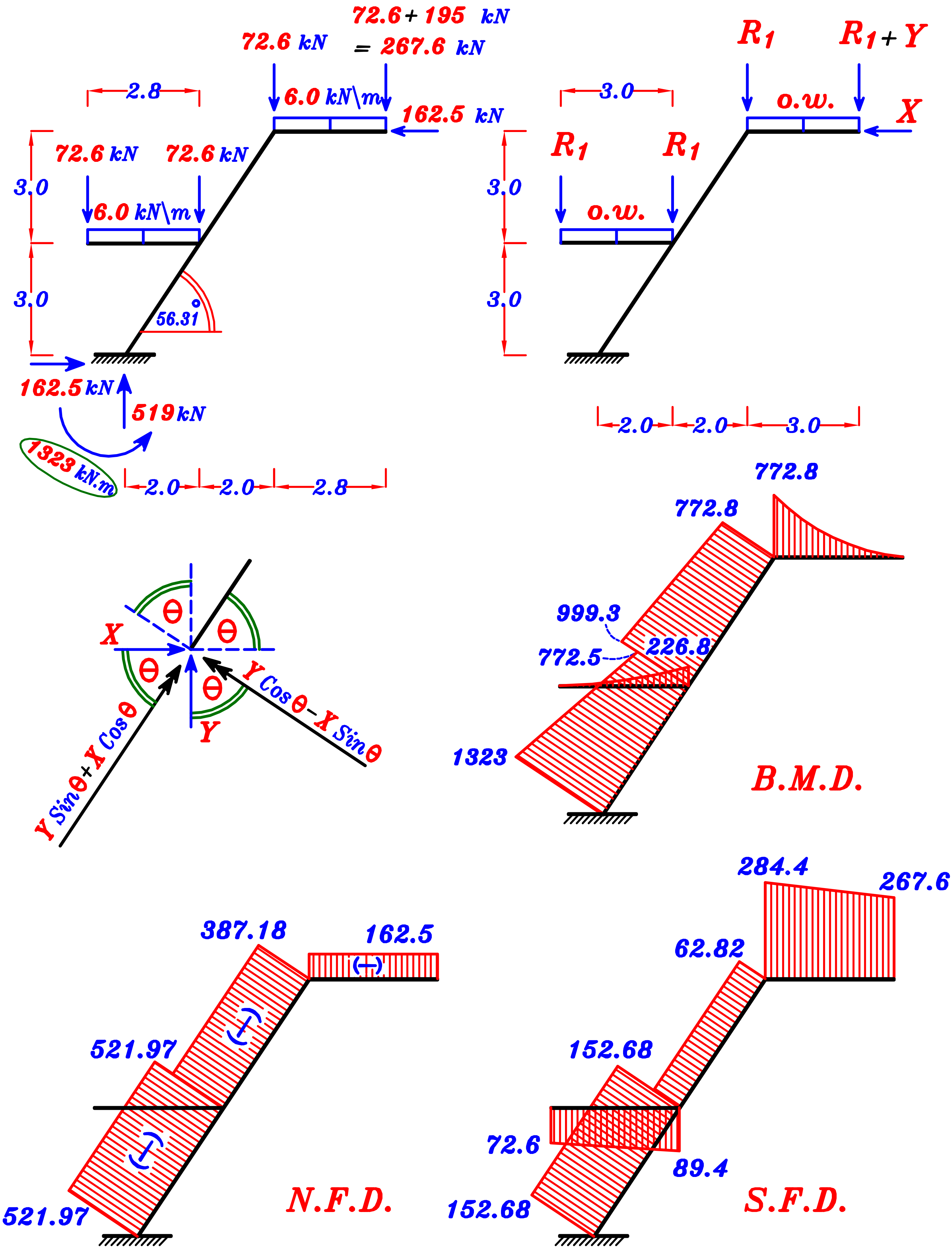
Plan (1-1)

$$w_a = w_e = O.W. + w_s \frac{L_s}{2}$$

$$= 3.0 + (6.50)\left(\frac{2.8}{2}\right) = 12.1 \ kN\backslash m'$$

$$R_1 = 12.10 * 6.0 = 72.6 \ kN$$

$$\boxed{R_1 = 72.6 \ kN}$$


72.6 + 195 kN
= 267.6 kN
72.6 kN
2.8
6.0 kN\m
162.5 kN
72.6 kN
72.6 kN
3.0
6.0 kN\m
3.0
56.31°
162.5 kN
519 kN
1323 kN.m
2.0
2.0
2.8
R1
R1 + Y
3.0
o.w.
X
R1
R1
3.0
o.w.
3.0
2.0
2.0
3.0
θ
X
Y
Y Cosθ − X Sinθ
Y Sinθ + X Cosθ
772.8
772.8
999.3
772.5
226.8
1323
B.M.D.
387.18
162.5
(−)
521.97
(−)
521.97
N.F.D.
284.4
267.6
62.82
152.68
72.6
89.4
152.68
S.F.D.

Example.

Figure 1 shows a sectional elevation and plan of a reinforced concrete shed. The shed covered by reinforced concrete slabs supported by a system of secondary beams (B_1) and Girders (G_1 & G_2) **It is required to :**

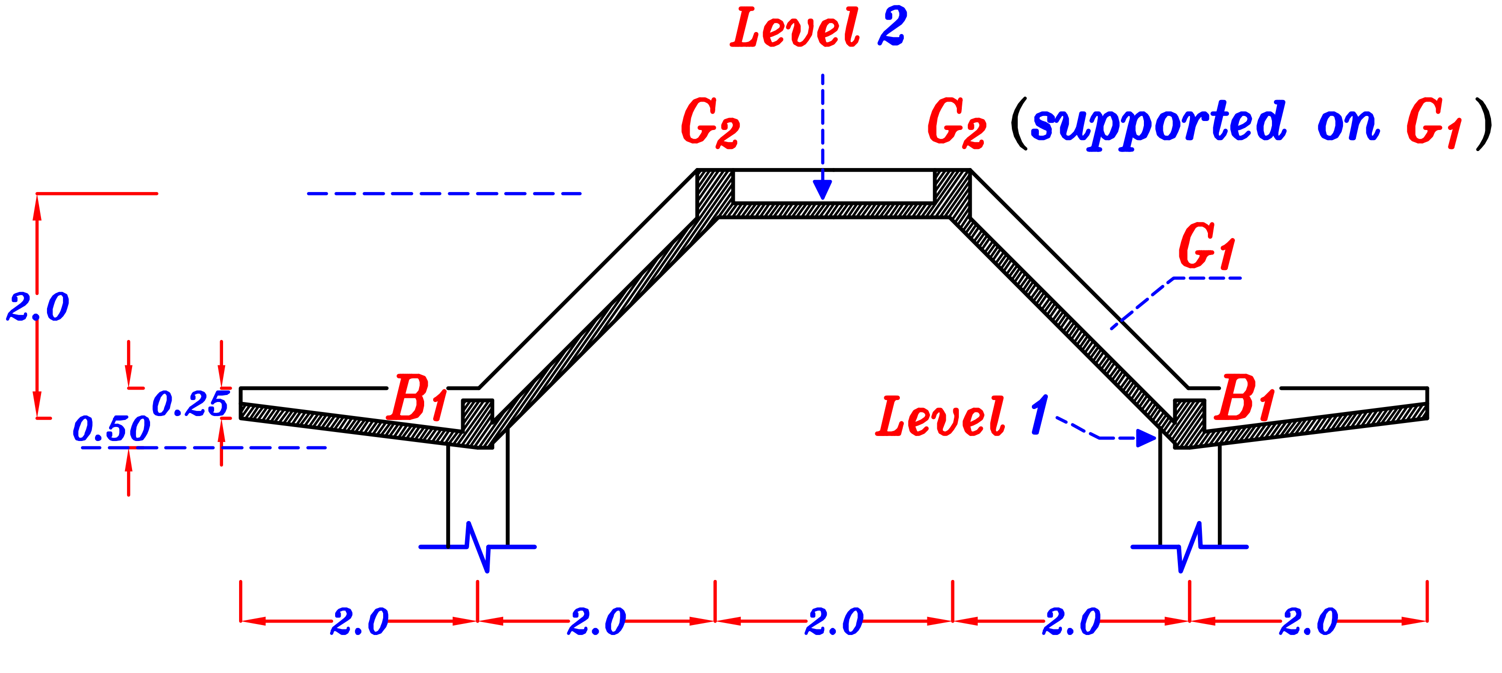
1 – Draw a structural plan showing the pattern of load distribution.

2 – Calculate the equivalent working loads for shear and moment For secondary Beams (B_1) and Girders (G_1 & G_2) .

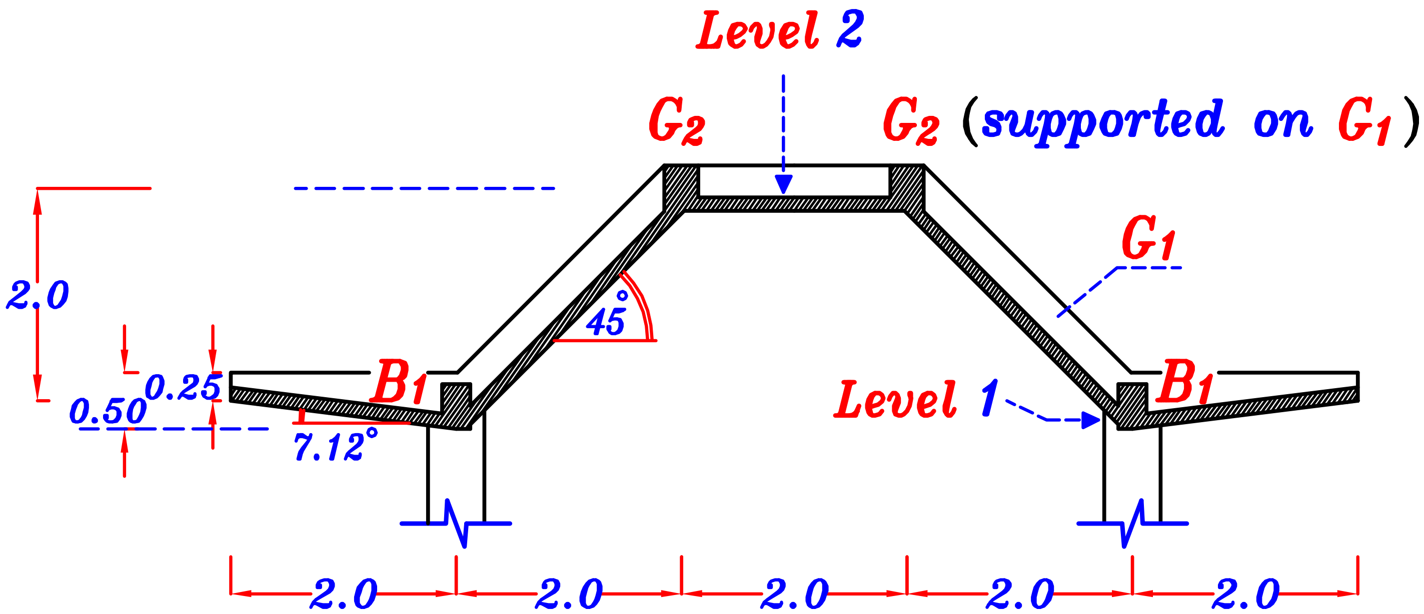
3 – Draw the N.F.D. (Total Loads) , S.F.D. (Total Loads) and (max–max B.M.D.) For Girder (G_1) only, Using ultimate limit loads.

Data:

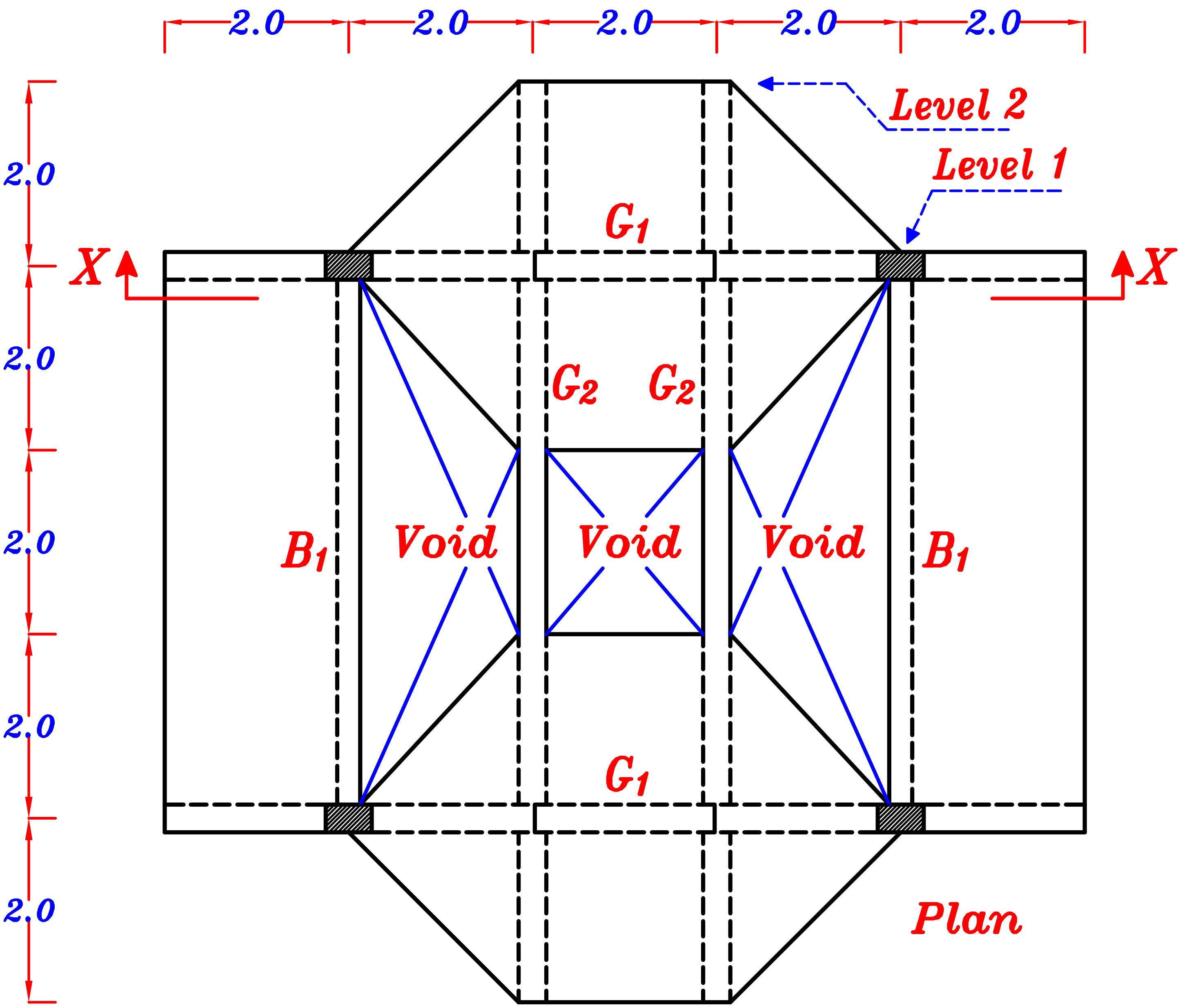
- Slab thickness $t_s = 140$ mm
- Live load = 1.5 kN\m² HL. projection.
- Floor cover = 1.0 kN\m²
- Own weight of beams = 3.0 kN\m
- Own weight of girders = 6.0 kN\m



Cross–Section (X–X)



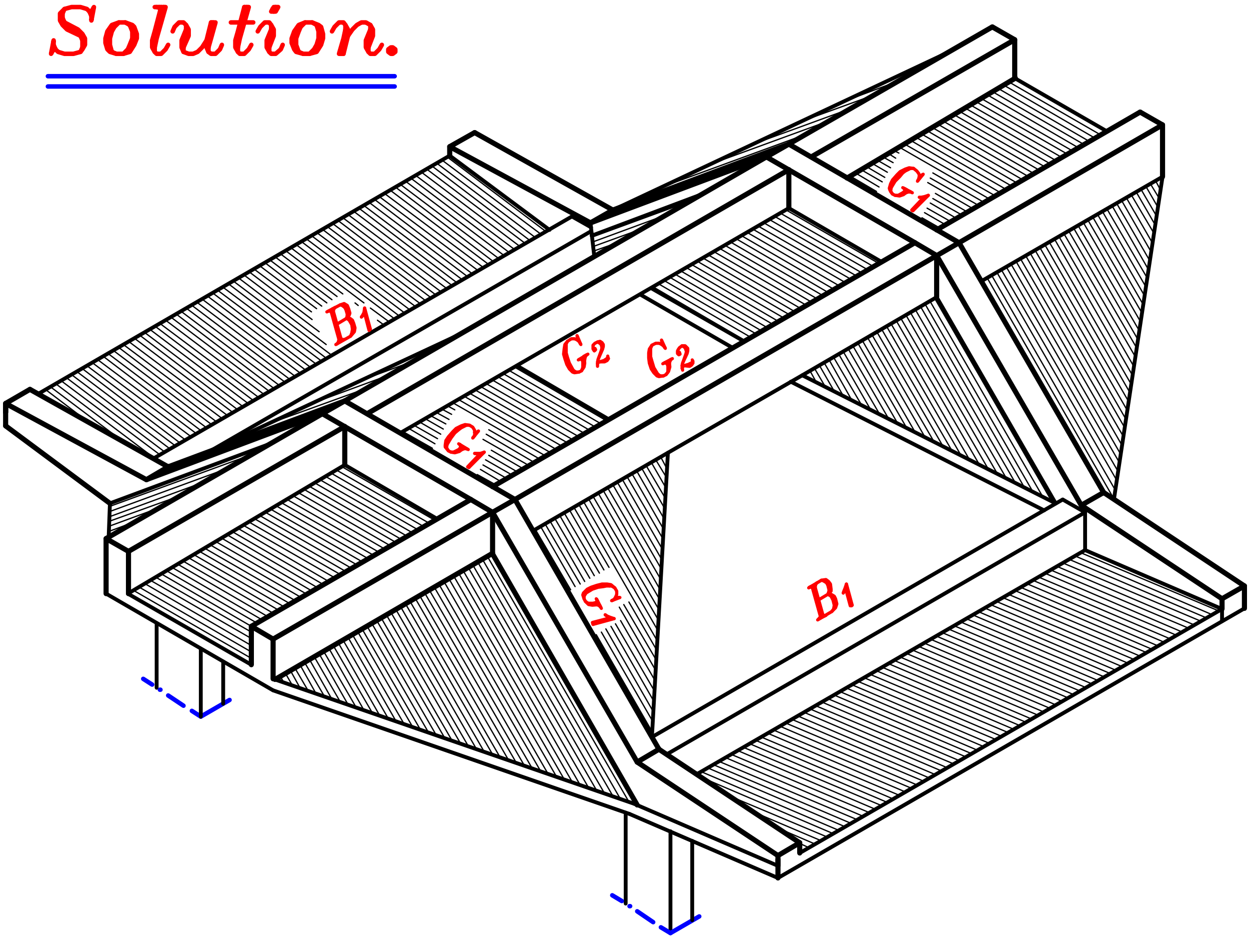
Cross-Section (X-X)



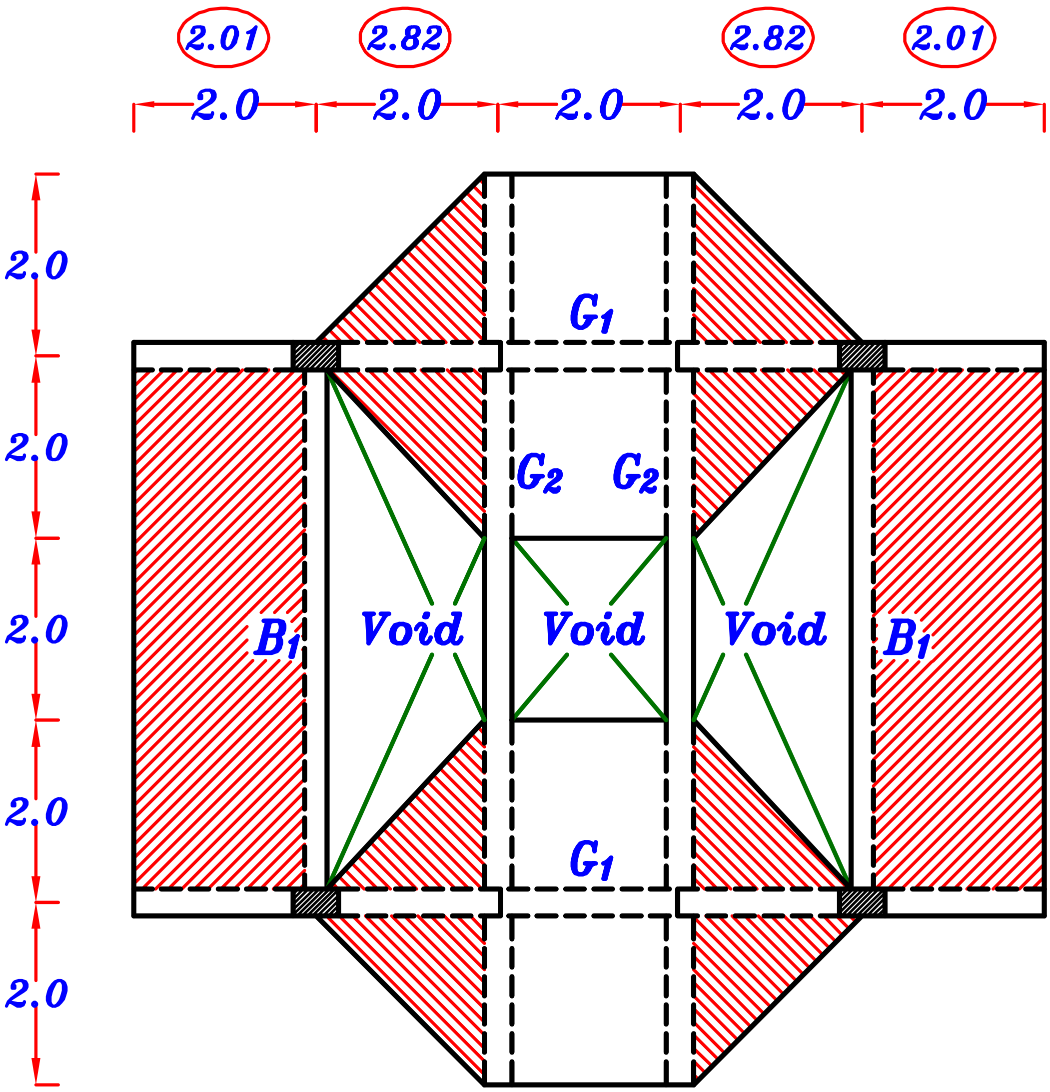
Plan

Figure 1

Solution.



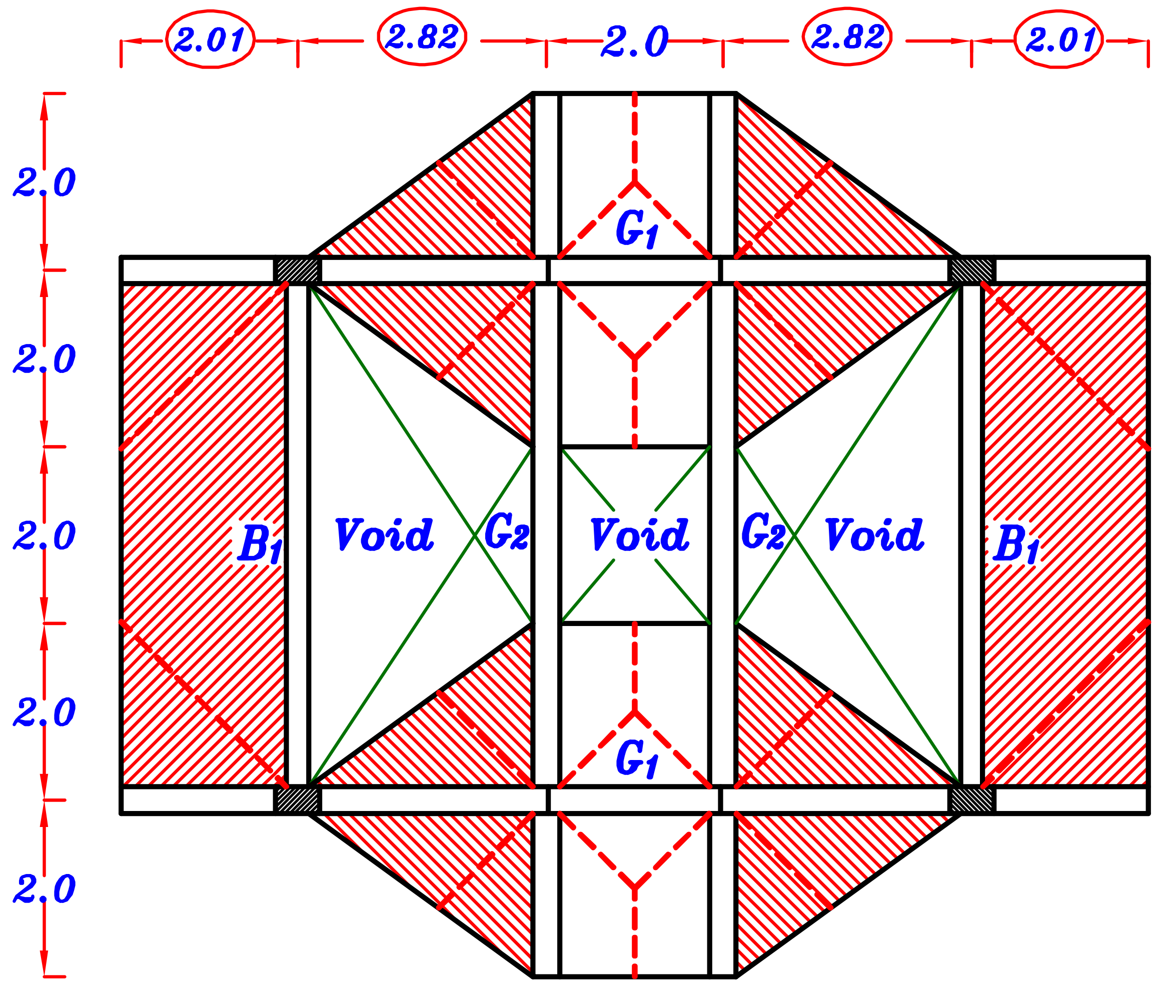
B1
G2
G2
G1
G1
G1
B1



2.01
2.82
2.82
2.01
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
G1
G2
G2
B1
Void
Void
Void
B1
G1

1 – Draw a structural plan showing the pattern of load distribution.

أرسم ال **plan** بالاطوال الحقيقيه بمقياس رسم مناسب لقياس بعض الاطوال منه .



g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.0 = 4.5 \ kN\backslash m^2$

$p_{sh} = L.L. = 1.5 \ kN\backslash m^2$ ----- HL. Slab.

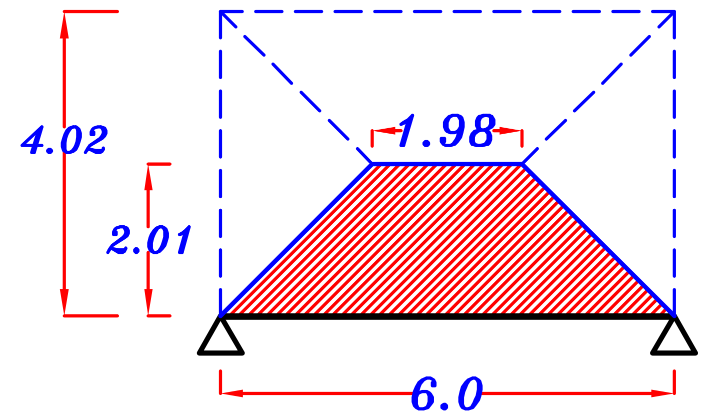
$p_{si1} = L.L. * Cos\,\theta = 1.5 * Cos\ 45^\circ = 1.06 \ kN\backslash m^2$ --- For Inclination 45°

$p_{si2} = L.L. * Cos\,\theta = 1.5 * Cos\ 7.12^\circ = 1.49 \ kN\backslash m^2$ --- For Inclination 7.12°

$\boxed{g_s = 4.5 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.5 \ kN\backslash m^2}$

$\boxed{p_{si1} = 1.06 \ kN\backslash m^2}$, $\boxed{p_{si2} = 1.49 \ kN\backslash m^2}$

B_1

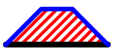


For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.02}{6}\right) = 0.665$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.02}{6}\right)^2 = 0.85$$

Load For Shear.



$$g_a = o.w. + C_a\, g_s\, L_c = 3.0 + (0.665)(4.50)(2.01) = 9.01 \text{ kN}\backslash m'$$

$$p_a = C_a\, p_{si2}\, L_c = (0.665)(1.49)(2.01) = 1.99 \text{ kN}\backslash m'$$

$$w_a = g_a + p_a = 9.01 + 1.99 = 11.0 \text{ kN}\backslash m'$$

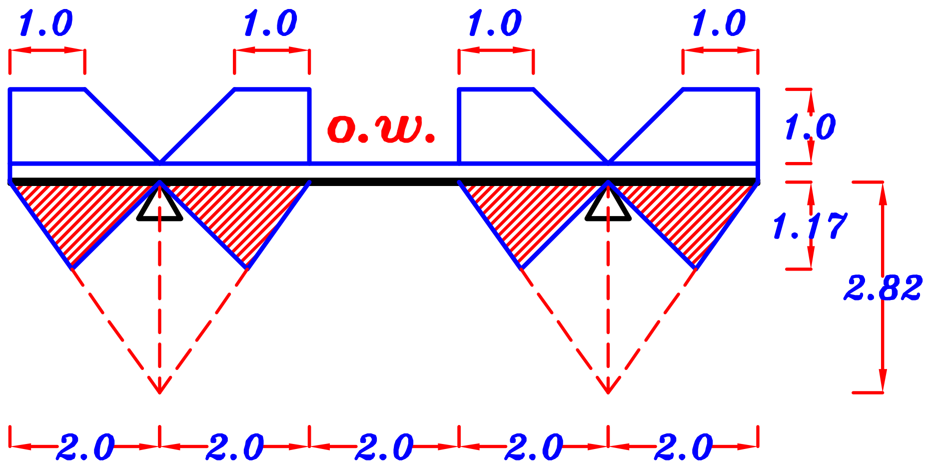
Load For Moment.

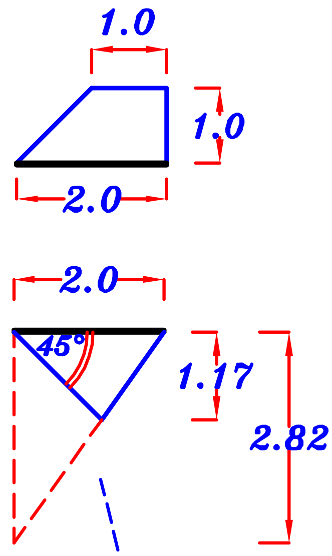
$$g_e = o.w. + C_e\, g_s\, L_c = 3.0 + (0.85)(4.50)(2.01) = 10.69 \text{ kN}\backslash m'$$

$$p_e = C_e\, p_{si2}\, L_c = (0.85)(1.49)(2.01) = 2.54 \text{ kN}\backslash m'$$

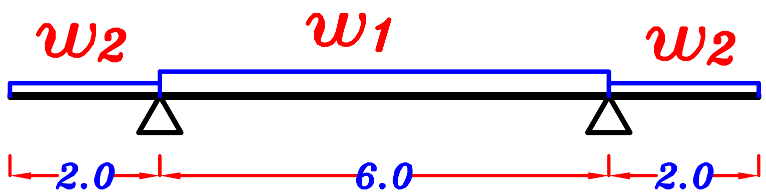
$$w_e = g_e + p_e = 10.69 + 2.54 = 13.23 \text{ kN}\backslash m'$$

G_2





يتم حساب الابعاد
من القياس من على الرسمه
لذا تم رسمها بمقياس رسم مناسب



w_1

$$\frac{\sum area}{span}\,1 = \frac{2\left(\frac{2+1}{2}\right)(1.0)}{6.0} = 0.50$$

$$\frac{\sum area}{span}\,2 = \frac{2\left(\frac{1}{2}*2*1.17\right)}{6.0} = 0.39$$

Load For Shear = Load For Moment.

$$g_{1a} = g_{1e} = O.W. + \frac{\sum area}{span}\,1 * g_s + \frac{\sum area}{span}\,2 * g_s$$

$$= 6.0 + (0.50)(4.5) + (0.39)(4.5) = 10.0 \quad kN\backslash m'$$

$$p_{1a} = p_{1e} = \frac{\sum area}{span}\,1 * p_{sh} + \frac{\sum area}{span}\,2 * p_{si1}$$

$$= (0.50)(1.5) + (0.39)(1.06) = 1.163 \; kN\backslash m'$$

$$w_{1a} = w_{1e} = g_1 + p_1 = 10.0 + 1.163 = 11.163 \; kN\backslash m'$$

w_2

$$\frac{\sum area}{span}\,1 = \frac{\left(\frac{2+1}{2}\right)(1.0)}{2.0} = 0.75$$

$$\frac{\sum area}{span}\,2 = \frac{\left(\frac{1}{2}*2*1.17\right)}{2.0} = 0.585$$

Load For Shear = Load For Moment.

$$g_{2a} = g_{2e} = O.W. + \frac{\sum area}{span}\,1 * g_s + \frac{\sum area}{span}\,2 * g_s$$

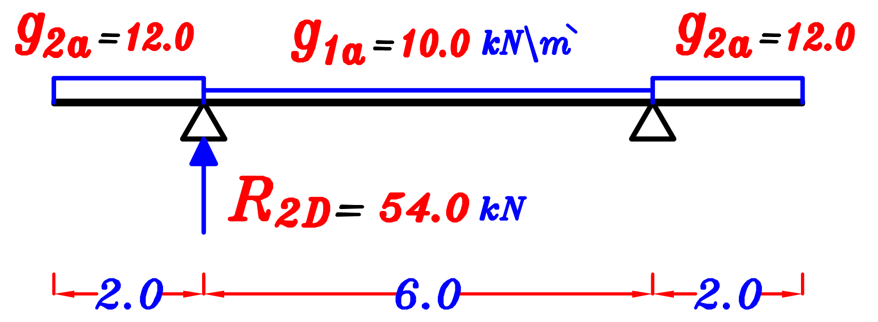
$$= 6.0 + (0.75)(4.5) + (0.585)(4.5) = 12.0 \ kN\backslash m`$$

$$p_{2a} = p_{2e} = \frac{\sum area}{span}\,1 * p_{sh} + \frac{\sum area}{span}\,2 * p_{si1}$$

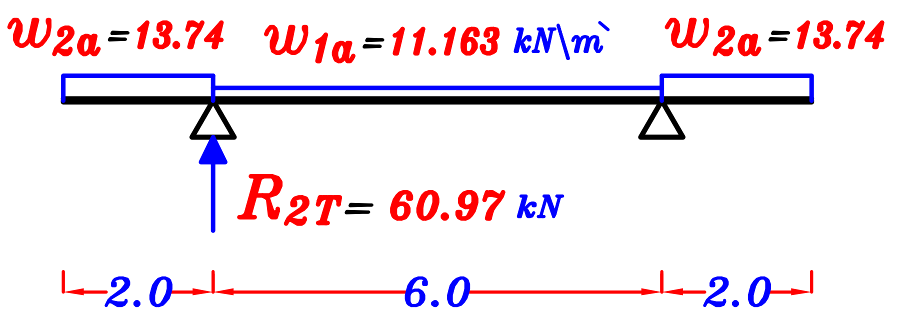
$$= (0.75)(1.5) + (0.585)(1.06) = 1.74 \ kN\backslash m`$$

$$w_{2a} = w_{2e} = g_2 + p_2 = 12.0 + 1.74 = 13.74 \ kN\backslash m`$$

Reaction of gireder G_2

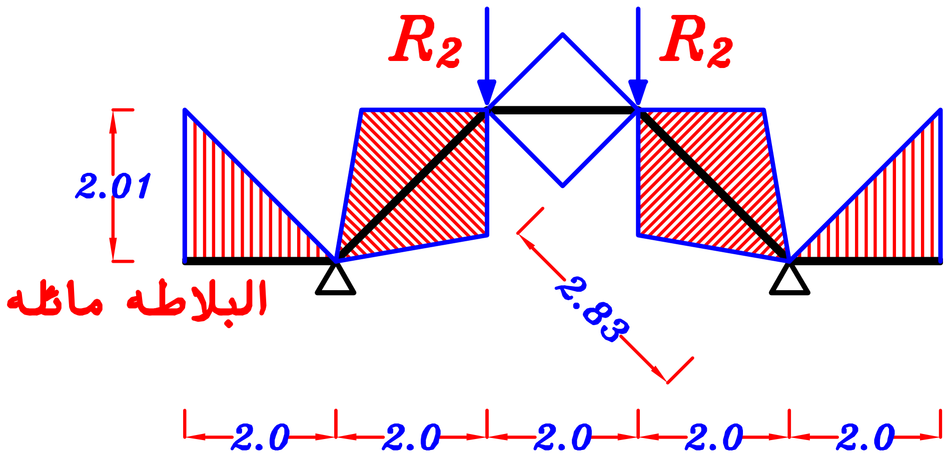


$$\boxed{R_{2D} = 54.0 \ kN}$$



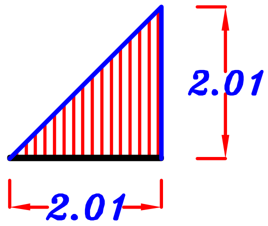
$$\boxed{R_{2T} = 60.97 \ kN}$$

G_1

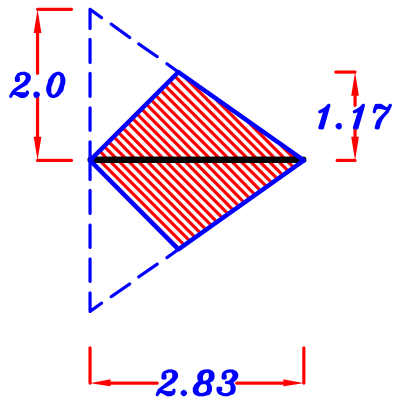


البلاطه مائله و لكن ال girder cantilever أفقي

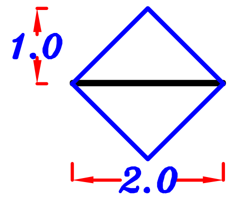
$$\frac{\sum area}{span} = \frac{\left(\frac{1}{2} * 2.01 * 2.01\right)}{2.0} = 1.01$$

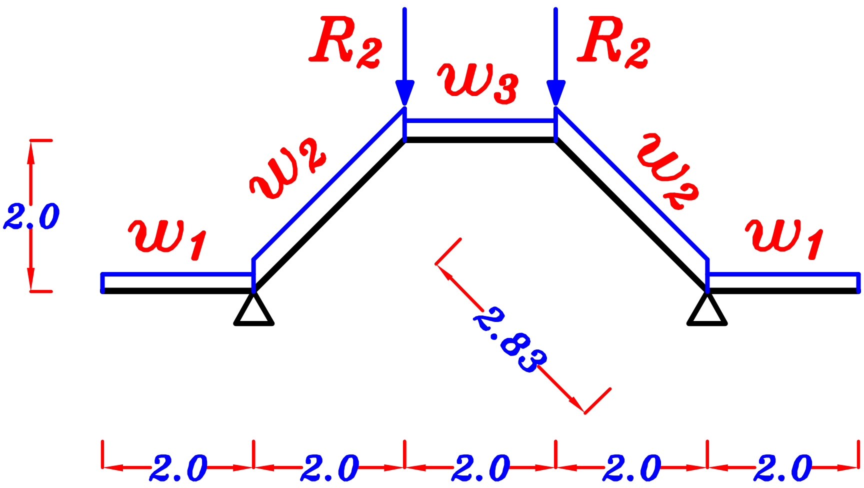


$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2} * 2.83 * 1.17\right)}{2.83} = 1.17$$



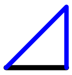
$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2} * 2 * 1.0\right)}{2.0} = 1.0$$





w_1

Load For Shear = Load For Moment



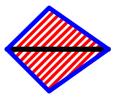
$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.01)(4.5) = 10.545 \ kN\backslash m'$$

$$p_1 = \frac{\sum area}{span} * p_{si2} = (1.01)(1.49) = 1.505 \ kN\backslash m'$$

$$w_1 = g + p = 10.545 + 1.505 = 12.05 \ kN\backslash m'$$

w_2

Load For Shear = Load For Moment



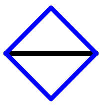
$$g_2 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.17)(4.5) = 11.265 \ kN\backslash m'$$

$$p_2 = \frac{\sum area}{span} * p_{si1} = (1.17)(1.06) = 1.24 \ kN\backslash m'$$

$$w_2 = g + p = 11.265 + 1.24 = 12.505 \ kN\backslash m'$$

w_3

Load For Shear = Load For Moment



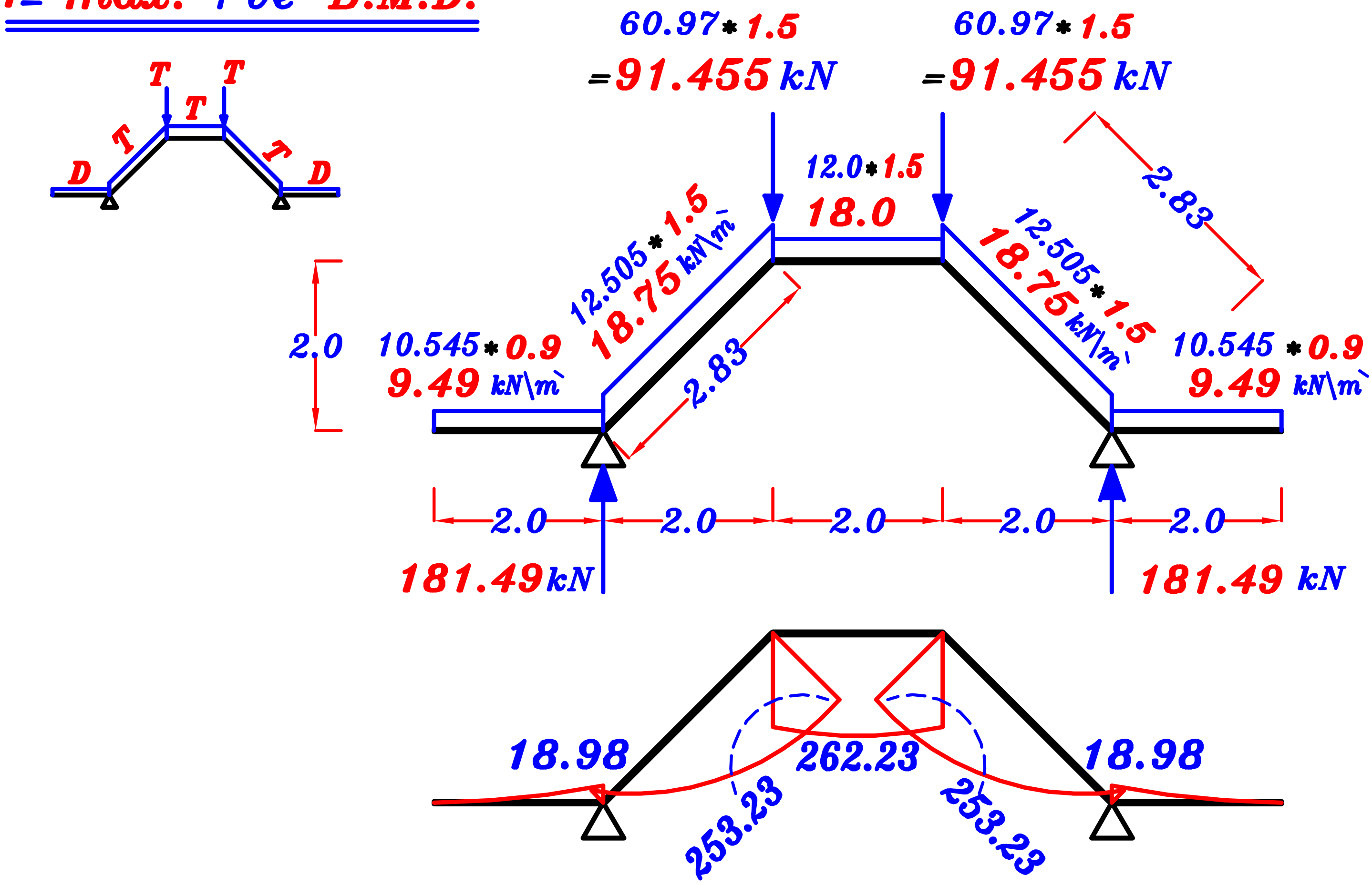
$$g_3 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.0)(4.5) = 10.5 \ kN\backslash m'$$

$$p_3 = \frac{\sum area}{span} * p_{sh} = (1.0)(1.5) = 1.50 \ kN\backslash m'$$

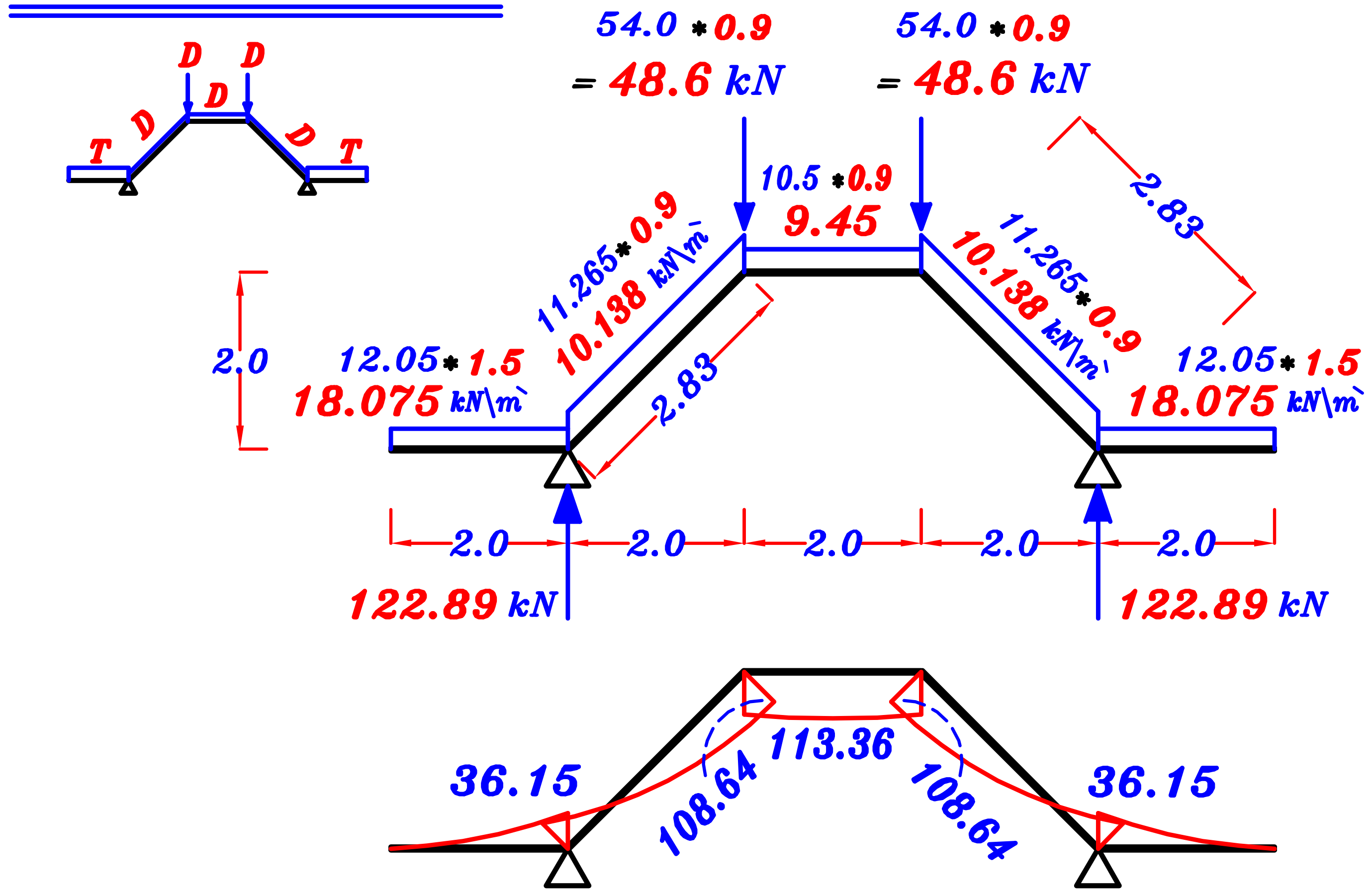
$$w_3 = g + p = 10.5 + 1.50 = 12.0 \ kN\backslash m'$$

max-max U.L. B.M.D. For the Girder. G_1

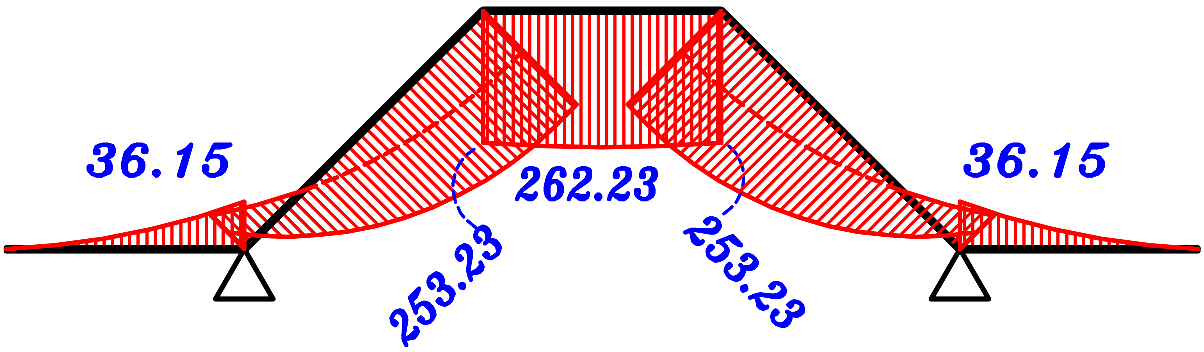
1- max. +ve B.M.D.



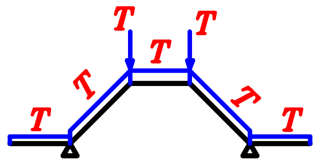
2- max. -ve B.M.D.

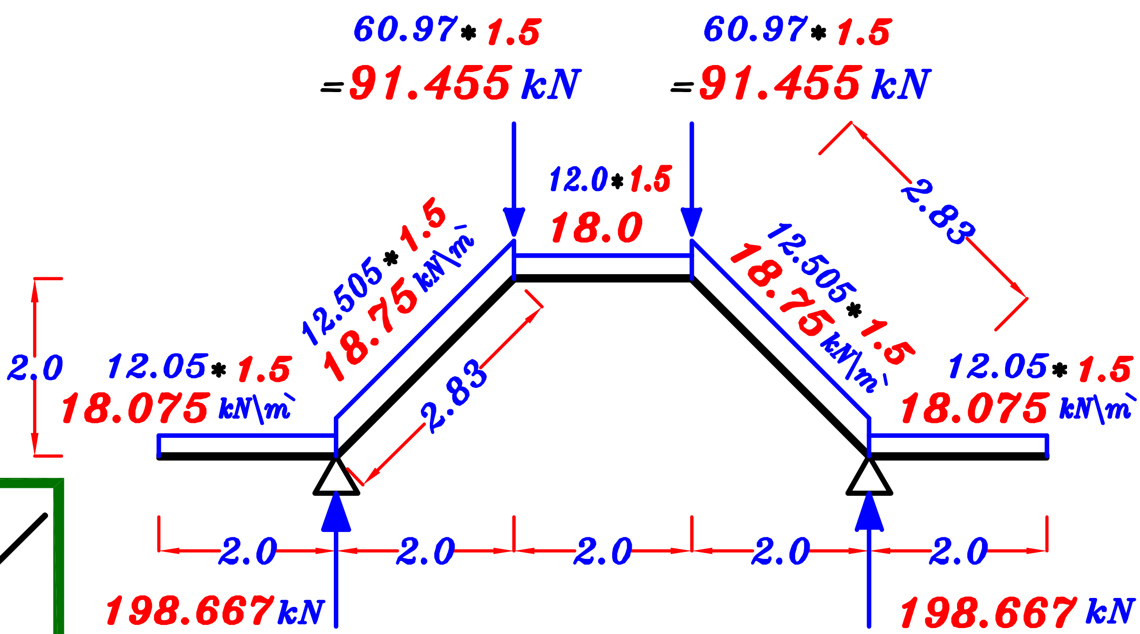


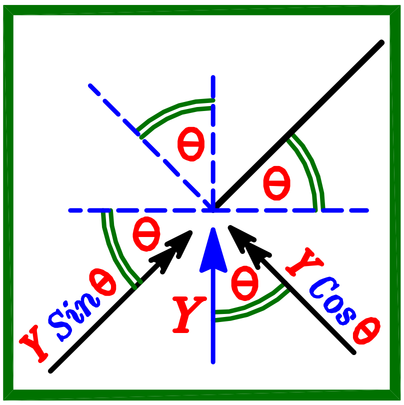
max–max U.L. B.M.D. For the Girder. G_1



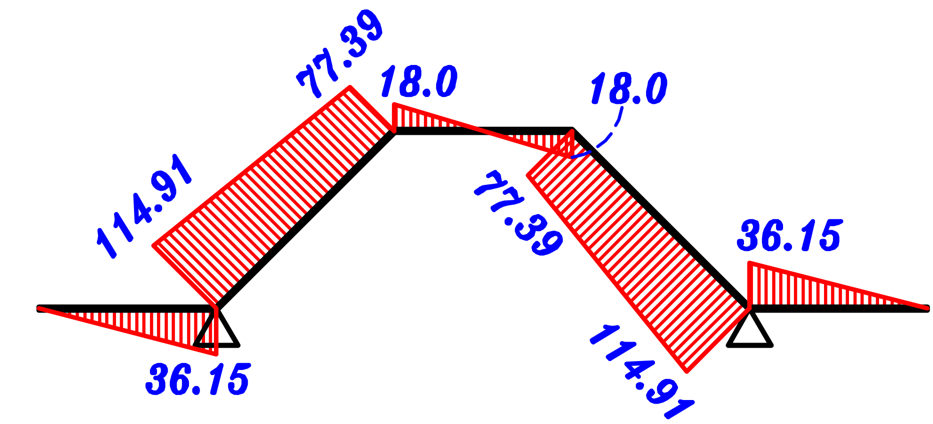
U.L. S.F.D. & N.F.D. For the Girder G_1







S.F.D.



N.F.D.